

EDN

13 SEP 1988

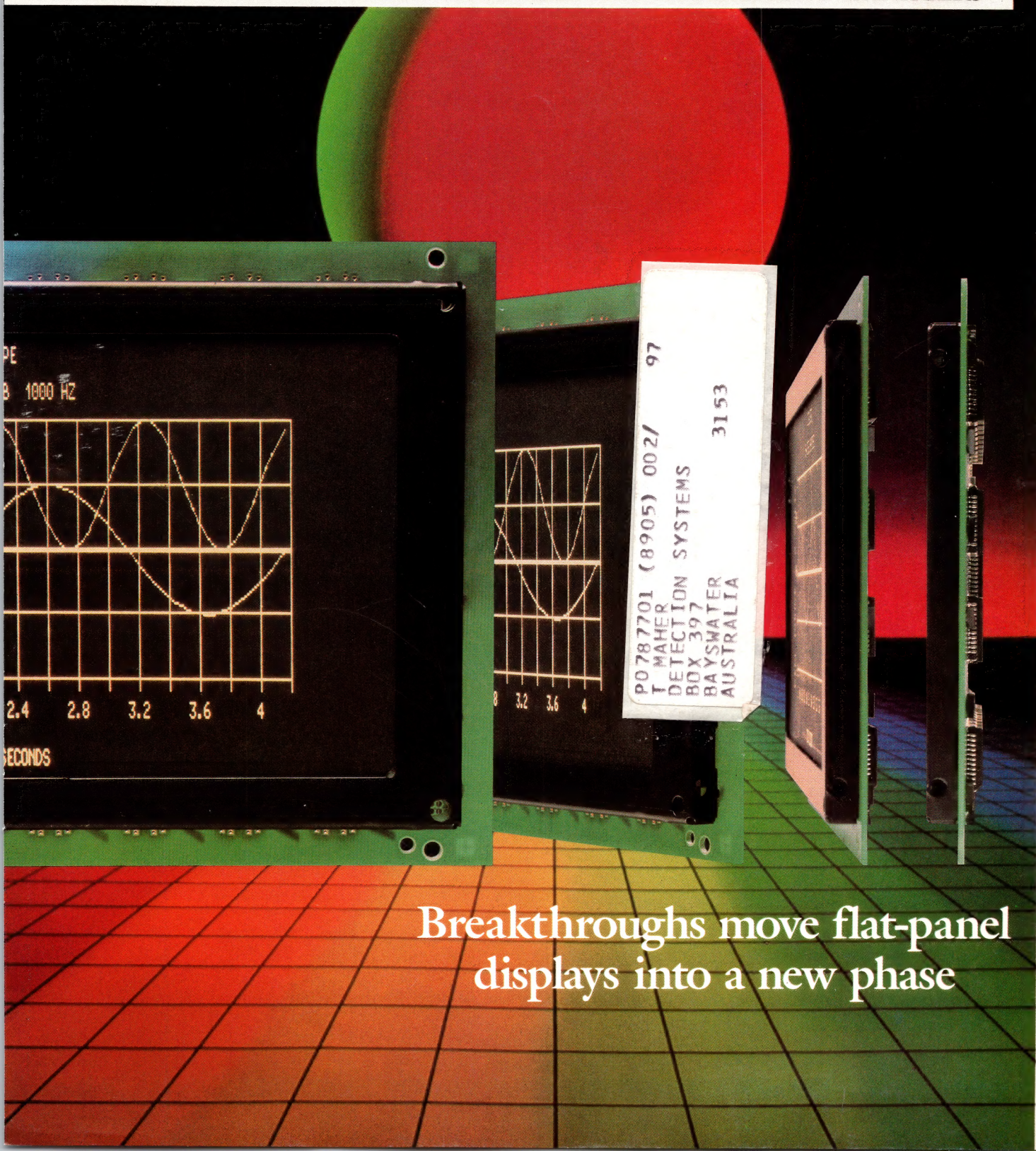
SPECIAL ISSUE:
Military electronics

Circuit simulation
for rad-hard designs

Peer-to-peer protocol eases
real-time communications

DRAM-controller ICs

ELECTRONIC TECHNOLOGY FOR ENGINEERS AND ENGINEERING MANAGERS



Breakthroughs move flat-panel
displays into a new phase

Devices' 29K. platform.



ADVANCED MICRO DEVICES. For more information, write "29K" on your letterhead and mail to:

P.O. Box 4, Westbury-on-Trym, Bristol BS9 3DS, United Kingdom.

Bruxelles (02-2) 771 91 42 • Hannover area (0511) 73 60 85 • Hong Kong (5) 8654525 • London area (04862) 22121
Manchester area (0925) 828008 • Milano (02) 3533241 • München (089) 41 14-0 • Osaka (06) 243-3250 • Paris (1) 49 75 10 10
Seoul (02) 784-7598 • Singapore (65) 225 7544 • Stockholm (08) 733 03 50 • Stuttgart (0711) 62 33 77 • Taiwan (02) 7122066
Tokyo (03) 345-8241 • Latin America, Fort Lauderdale, Florida/U.S.A. Tel: (305) 484-8600 Tlx: (510) 955-4261 amd ffl.

29K logo is a trademark of Advanced Micro Devices. © Advanced Micro Devices, Inc. 1988. 

Advanced Micro
The next

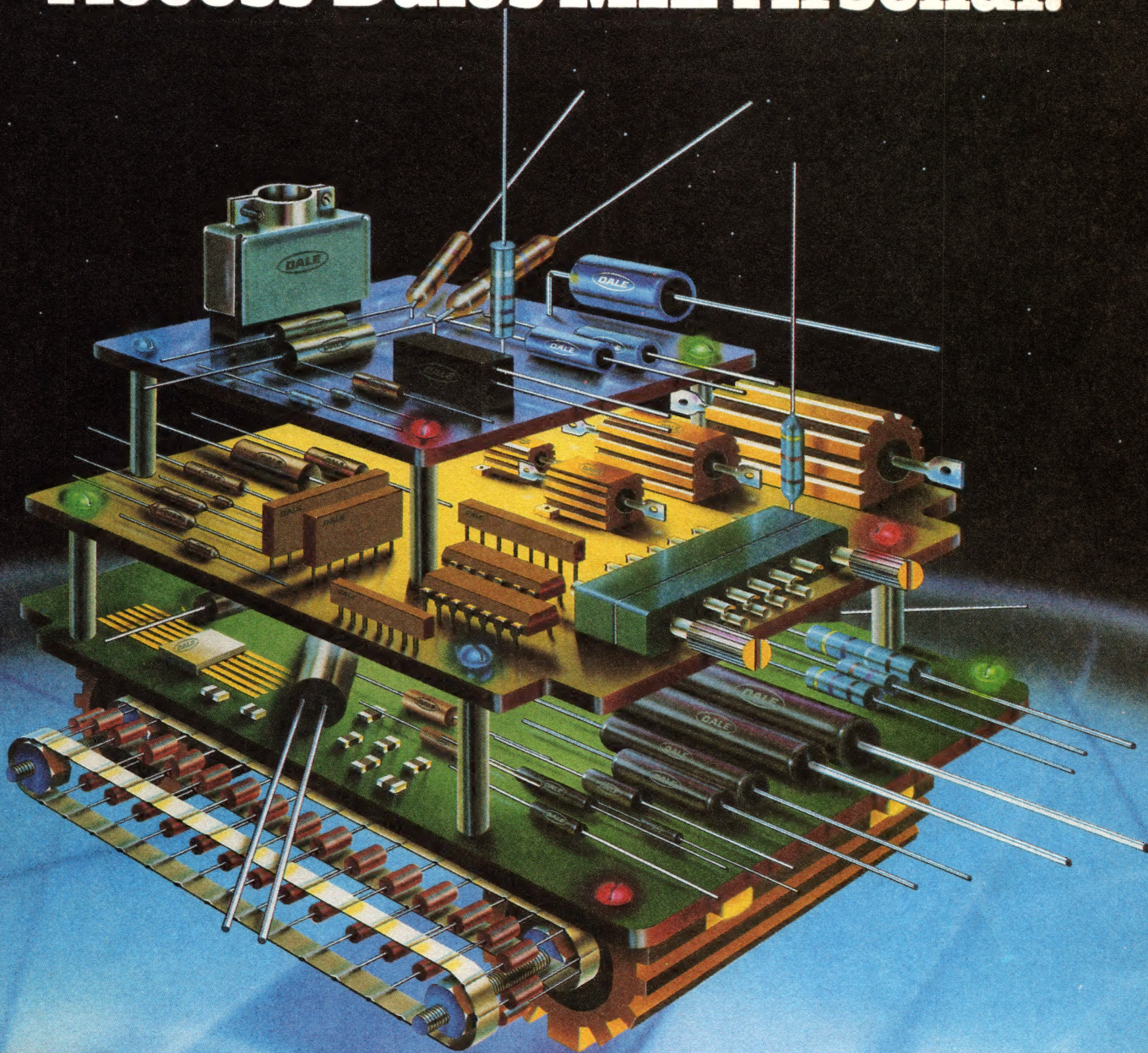


Seventeen MIPS with a single
32-bit RISC chip. Sustained. 42,000
dhrystones. In CMOS. On the shelf.
Complete hardware and software
development support. Optimizing
compilers. Assemblers. Debuggers.
Industry standard operating systems.
Hardware development tools.



Documentation,
training and customer
support. Now.

Access Dale's MIL Arsenal.



Be prepared to save time and add efficiency when buying or specifying MIL components. Check the list at right then call Dale®. We have carefully assembled the industry's broadest stock of MIL resistors including networks...chips...wirewound and metal film. And, we can also supply RF chokes and connectors to popular MIL requirements. This complete arsenal is stockpiled at strategic factory and distributor locations — giving you a reliable source of supply that will assure operation with low inventories. For complete information contact your Dale representative, your distributor, or call the factory.

RESISTOR NETWORKS

Phone 915-592-3253

MIL-R-83401

- RZ010, RZ020, RZ030
- RZ040, RZ050, RZ060
- RZ070, RZ080, RZ090

THICK FILM CHIPS

Phone 402-371-0080

MIL-R-55342/2,3,4,5,6

- RM0505, RM1005, RM1505
- RM2208, RM0705

METAL FILM RESISTORS

Phone 402-371-0080

MIL-R-122

MIL-R-10509

- RN50, RN55, RN60
- RN65, RN70

MIL-R-22684

- RL07, RL20

MIL-R-39017

- RLR05, RLR07, RLR20

MIL-R-55182

- RNR55, RNR60, RNR65
- RNC50, RNC55, RNC60
- RNC65, RNC70

WIREWOUND RESISTORS

Phone 402-564-3131

MIL-R-26

- RW67, RW68, RW69
- RW70, RW74, RW78, RW79
- RW80, RW81

MIL-R-18546

- RE60, RE65, RE70
- RE75, RE77, RE80

MIL-R-39007

- RWR71, RWR74, RWR78
- RWR80, RWR81, RWR82
- RWR84, RWR89

MIL-R-39009

- RER40, RER45, RER50
- RER55, RER60, RER65
- RER70, RER75

INDUCTORS

Phone 605-665-9301

MIL-C-15305

- MS75087, MS75088, MS75089
- MS75083, MS75084, MS75085
- MS14046, MS18130, MS90538

CONNECTORS

Phone 605-665-9301

MIL-C-28748/7,8

Dale makes your basics better.

DALE®

100% induced voltage tested for shorted turns.

Deliveries on larger orders scheduled out as you need them to 12 months and longer.

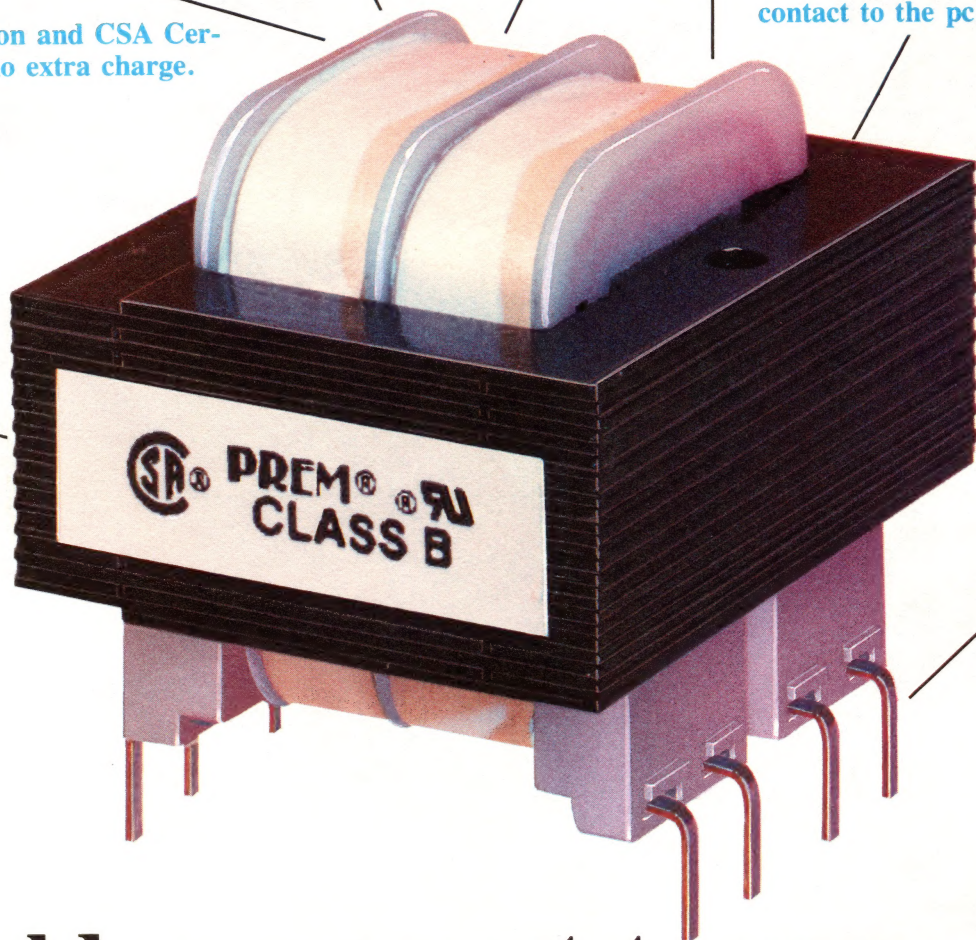
Epoxy impregnated with 100% solids to withstand most aqueous and solvent printed circuit board cleaning systems, thus requiring no post-wash soldering.

Immediate delivery on small quantities.

Special packing to prevent transit damage.

Pre-tinned to ensure good solder contact to the pc board.

UL Recognition and CSA Certification at no extra charge.



Would you expect to pay less for this transformer?

Even with quality like this, Prem costs you less. Our pc power transformer catalog includes cross references to Microtran, Signal, Stancor and Triad part numbers. We invite you to compare. At PREM, we give you more than just a great price, we give you a superior product and exceptional service.

Send for our Free Catalog, today!

For immediate technical data, you can find us in Volume A of 1987/88 EEM. Or call us.

PREM®
MAGNETICS,
INCORPORATED

3521 North Chapel Hill Road
McHenry, Illinois 60050
Tel. 815-385-2700
TWX 910-642-3763
FAX 815-385-8578

tiny SPDT switches

absorptive... reflective

dc to 4.6 GHz from \$32⁹⁵₍₁₋₂₄₎

Tough enough to pass stringent MIL-STD-883 tests, useable from dc to 6GHz and smaller than most RF switches, Mini-Circuits' hermetically-sealed (reflective) KSW-2-46 and (absorptive) KSWA-2-46 offer a new, unexplored horizon of applications. Unlike pin diode switches that become ineffective below 1MHz, these GaAs switches can operate down to dc with control voltage as low as -5V, at a blinding 2ns switching speed.

Despite its extremely tiny size, only 0.185 by 0.185 by 0.06 in., these switches provide 50dB isolation (considerably higher than many larger units) and insertion loss of only 1dB. The absorptive model KSWA-2-46 exhibits a typical VSWR of 1.5 in its "OFF" state over the entire frequency range. These surface-mount units can be soldered to pc boards using conventional assembly techniques. The KSW-2-46, priced at only \$32.95, and the KSWA-2-46, at \$48.95, are the latest examples of components from Mini-Circuits with unbeatable price/performance.

Connector versions, packaged in a 1.25 x 1.25 x 0.75 in. metal case, contain five SMA connectors, including one at each control port to maintain 3ns switching speed.

Switch fast... to Mini-Circuits' GaAs switches.

SPECIFICATIONS

Pin. Model	KSW-2-46		KSWA-2-46	
Connector Version	ZFSW-2-46		ZFSWA-2-46	
FREQ. RANGE	dc-4.6 GHz		dc-4.6 GHz	
INSERT. LOSS (db)	typ	max	typ	max
	dc-200MHz	0.9 1.1	0.8 1.1	
	200-1000MHz	1.0 1.3	0.9 1.3	
	1-4.6GHz	1.3 1.7	1.5 2.6	
ISOLATION (dB)	typ	min	typ	min
	dc-200MHz	60 50	60 50	
	200-1000MHz	45 40	50 40	
	1-4.6GHz	30 23	30 25	
VSWR (typ)	ON	1.3:1	1.3	
	OFF	—	1.4	
SW. SPEED (nsec)				
rise or fall time	2(typ)		3(typ)	
MAX RF INPUT (bBm)				
	up to 500MHz	+17	+17	
	above 500MHz	+27	+27	
CONTROL VOLT.	-5V on, OV off		-5V on, OV off	
OPER/STOR TEMP.	-55° to +125°C		-55° to +125°C	
PRICE (1-24)	\$32.95		\$48.95	
	\$72.95		\$88.95	

finding new ways ...
setting higher standards

Mini-Circuits

A Division of Scientific Components Corporation

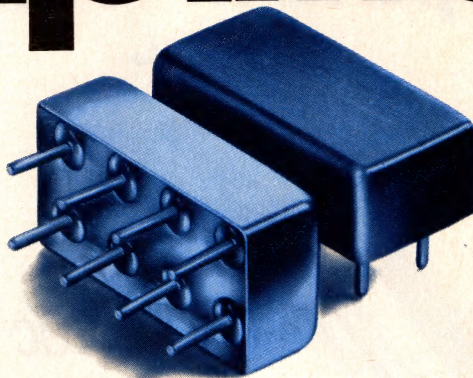
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500

Fax (718) 332-4661 Domestic and International Telexes: 6852844 or 620156

C 117 REV. D

CIRCLE NO 11

rugged plug-in amplifiers



0.5 to 1000 MHz from \$13⁹⁵ (5 to 24 qty)

Tough enough to meet full MIL-specs, capable of operating over a wide -55° to $+100^{\circ}\text{C}$ temperature range, in a rugged package... that's Mini-Circuits' new MAN-amplifier series. The MAN-amplifier's tiny package (only 0.4 by 0.8 by 0.25 in.) requires about the same pc board area as a TO-8 and can take tougher punishment with leads that won't break off. Models are unconditionally stable and available covering frequency ranges 0.5 to 500MHz and 0.5 to 1000MHz, and NF as low as 2.8dB.

Prices start at only \$13.95, **including** screening, thermal shock -55°C to $+100^{\circ}\text{C}$, fine and gross leak, and burn-in for 96 hours at 100°C under normal operating voltage and current.

Internally the MAN amplifiers consist of two stages, including coupling capacitors. A designer's delight, with all components self-contained. Just connect to a dc supply voltage and get up to 28dB gain with +9dBm output.

The new MAN-amplifier series...
another Mini-Circuits' price/performance breakthrough.

MODEL	FREQ. RANGE (MHz) f_L to f_U	GAIN dB min flatness††	MAX. OUT/PWR† dBm	NF dB (typ)	DC PWR 12V, mA	PRICE \$ ea. (5-24)
MAN-1	0.5-500	28 1.0	8	4.5	60	13.95
MAN-2	0.5-1000	19 1.5	7	6.0	85	15.95
MAN-1LN	0.5-500	28 1.0	8	2.8	60	15.95
◇MAN-1HLN	10-500	10 0.8	15	3.7	70	15.95

††Midband $10f_L$ to $f_{U/2}$, $\pm 0.5\text{dB}$

†1dB Gain Compression

◇Case Height 0.3 In.

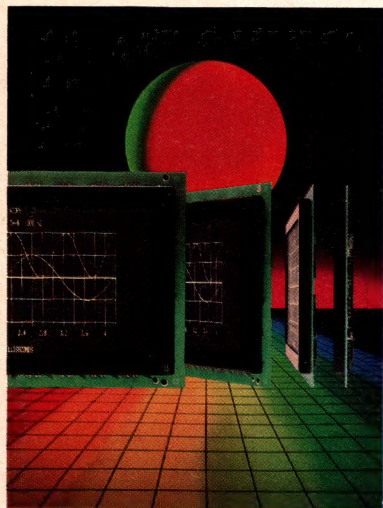
Max input power (no damage) +15dBm; VSWR in/out 1.8:1 max.

finding new ways ...
setting higher standards

Mini-Circuits

A Division of Scientific Components Corporation
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500
Fax (718) 332-4661 Domestic and International Telexes: 6852844 or 620156

CIRCLE NO 12



On the cover: Manufacturers are working to make flat-panel displays that are suitable for more and more complex applications, while improving performance levels and lowering their cost. See pg 138. (Photo courtesy Cherry Electrical Products)

SPECIAL ISSUE: MILITARY ELECTRONICS

SPECIAL REPORT

Flat-panel displays

138

The technology and manufacturing processes for flat-panel displays are changing fast—particularly for large-area displays with expanded information content. In choosing a model, however, you need to consider other aspects too.—*Dave Pryce, Associate Editor*

DESIGN FEATURES

Simulation helps you design radiation-hard circuits for space

161

You no longer need to use guesswork, rules of thumb, or prohibitively expensive test protocols to predict the effects of manmade and naturally occurring radiation on spaceborne electronic assemblies.—*Kevin Walsh, Electrical Engineering Software Inc and Gary Lum, PhD, Lockheed Missiles and Space Co Inc*

Peer-to-peer protocol facilitates real-time communications

179

The low communications overhead of the CSMA/DCR peer-to-peer protocol makes it desirable for real-time network applications.—*Deif N Atallah, Intel Corp*

Testability is crucial in PLD-circuit design

191

Compared with standard logic parts, PLDs tend to have higher defect rates and require a larger investment in test-program development. As a result, engineers must make testability a prime design goal.—*Peter de Bruyn Kops, Anvil Software*

Retargetable tools ease microprogramming of SIMD processors

205

You can improve your single-instruction, multiple-data processors dramatically by using effective organization and management techniques. Retargetable tool sets help you program these massively concurrent processors conveniently and inexpensively.—*Robert A Mueller and Daniel R Benua, Quantitative Technology Corp*

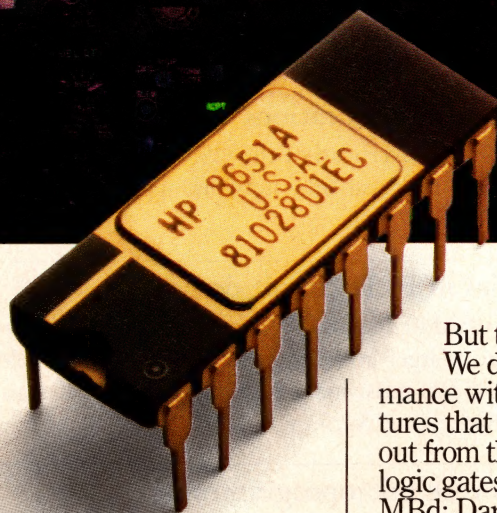
Continued on page 7

EDN® (ISSN 0012-7515) is published 40 times a year (biweekly with 1 additional issue a month, except for July which has 3 additional issues) by Cahners Publishing Company, A Division of Reed Publishing USA, 275 Washington Street, Newton, MA 02158-1630. Terrence M McDermott, President; Frank Sibley, Electronics/Computer Group Vice President; Jerry D Neth, Vice President/Publishing Operations; J J Walsh, Financial Vice President/Magazine Division; Thomas J Dellamaria, Vice President/Production and Manufacturing. Circulation records are maintained at Cahners Publishing Company, 44 Cook Street, Denver, CO 80206-5800. Telephone: (303) 388-4511. Second-class postage paid at Denver, CO 80206-5800 and additional mailing offices. POSTMASTER: Send address corrections to EDN® at the Denver address. EDN® copyright 1988 by Reed Publishing USA; Saul Goldweitz, Chairman; Ronald G Segel, President and Chief Executive Officer; Robert L Krakoff, Executive Vice President; William M Platt, Senior Vice President. Annual subscription rates for nonqualified people: USA, \$100/year; Canada/Mexico, \$115/year; Europe air mail, \$135/year; all other nations, \$135/year for surface mail and \$210/year for air mail. Except for special issues where price changes are indicated, single copies of regular issues are available for \$6, \$8, and \$10 (USA, Canada/Mexico, and foreign). Please address all subscription mail to Eric Schmieder, 44 Cook Street, Denver, CO 80206-5800.

The first hermetic optocouplers certified to MIL-STD-1772 are from HP

we never stop asking

What if...



When you need hermetic optocouplers, consider HP your primary source. We are the first company to get U.S. Government approval for our hybrid optocoupler manufacturing line. Our entire family of 8- and 16-pin hermetic optocouplers has been line certified to meet the new tough DESC requirements (MIL-STD-1772) for hybrid devices.

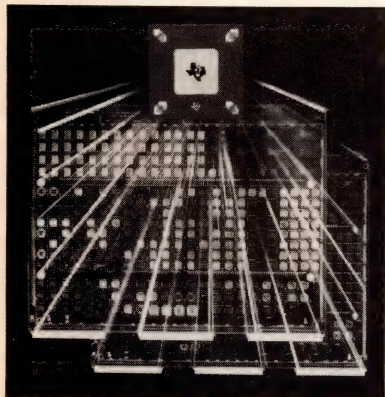
But that's only half of it. We deliver high reliability performance with carefully engineered features that make your products stand out from the competition: high speed logic gates with data rates up to 13 MBd; Darlington amplifier detector circuits with a current transfer ratio of up to 1,500%; a unique logic interface with either AC or DC input for voltage or current sensing.

If you would like to know more about how to get HP hermetic optocouplers, date-coded to reflect their line certification, just circle the reader service number on the reply card in this magazine.

To order, contact your nearest HP distributor. In the U.S.: Almac Electronics, Hall-Mark, Hamilton/Avnet, or Schweber. In Canada: Hamilton/Avnet or Zentronics Ltd.


CG08710

 **HEWLETT
PACKARD**



You no longer need a supercomputer to run AI-related programs: many such programs will run on modest machines such as the IBM PC/AT and compatibles (pg 71).

EDN magazine
now offers
Express Request,
a convenient way
to retrieve product
information by
phone. See the
Reader Service
Card in the front
for details on how
to use this free
service.

Express Request 

TECHNOLOGY UPDATE

PC-based development products move AI out of the classroom, into the workplace 71

Artificial intelligence (AI) was the dreamchild of the 50s—or perhaps it was Aladdin's lamp, which would release a genie of unlimited power and wisdom.—*Chris Terry, Associate Editor*

Dynamic-RAM-controller ICs squeeze maximum performance from DRAMs 91

Despite this year's acute parts shortage and the subsequent price increase, dynamic RAMs (DRAMs) still cost less than static RAMs (SRAMs) on a bit-by-bit basis, and they still take up less room on your pc board.—*Steven H Leibson, Regional Editor*

PRODUCT UPDATE

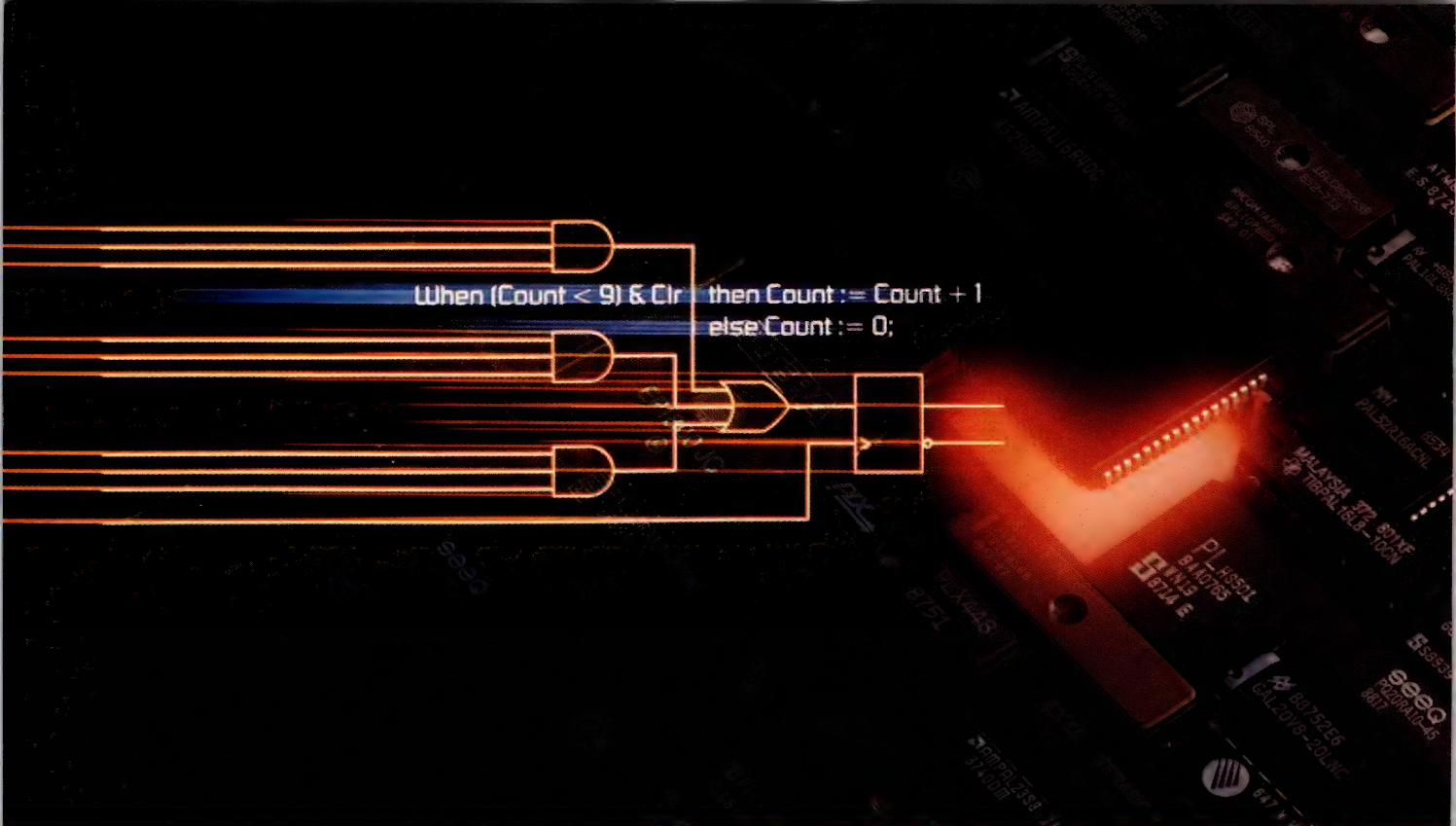
Communications and development package	107
Gang-program unit	108
Delta codec	110
DSO (digital-storage oscilloscope)	112
Removable-disk storage system	117
Low-cost PC clone	120

DESIGN IDEAS

555 timer triggers phase-control circuit	219
PWM DAC simplifies output filtering	220
Add text to composite-video signal	222
First-order allpass filter uses an MF10	222
Motor controller eliminates tachometer	226

Continued on page 9

Cahners Publishing Company, A Division of Reed Publishing USA ☐ Specialized Business Magazines for Building & Construction ☐ Manufacturing ☐ Foodservice & Lodging ☐ Electronics & Computers ☐ Interior Design ☐ Printing ☐ Publishing ☐ Industrial Research & Technology ☐ Health Care ☐ and Entertainment. Specialized Consumer Magazines: ☐ American Baby ☐ and Modern Bride.



17 MILLION PLDS A MONTH BEGIN WITH DATA I/O.

No company supports as many programmable logic devices as Data I/O®—virtually every PLD on the market. From design, to programming and test, Data I/O is the industry choice for PLD development tools.

UNIVERSAL SUPPORT FOR EVERY PLD MANUFACTURER.

We give you the freedom to choose the right PLD for your design—from any manufacturer. You can use our tools to design and program all PLD architectures, including PALs, FPLAs, PLEs and EPLDs, and all technologies from vertical-cell AIM, ECL, and CMOS to bipolar. And you can pick any package—DIP, PLCC, LCC or SOIC.

UNIVERSAL DESIGN TOOLS. ABEL™ 3.0, Data I/O's high-level design language, lets you describe your design with any combination of equations, state diagrams, or truth tables. For multiple PLD design, use the advanced logic synthesis capabilities of GATES™ from FutureNet®. And for complete



device testability, PLDtest® is our universal tool for automatic fault grading and test vector generation.

UNIVERSAL PROGRAMMING TOOLS.

The UniSite™ 40, our most sophisticated programmer, handles all devices—memory, logic, and microcontrollers—in a single site. The modular approach to logic programming is the 29B with a

LogicPak™. Or for portable convenience, choose the 60A.

UNIVERSALLY APPROVED BY PLD MANUFACTURERS. With Data I/O, you can depend on the accuracy and reliability of your programmed PLD. We work with semiconductor manufacturers—long before devices are released—to develop, and obtain approvals for, our programming algorithms. So reliable support will always be ready when you need it.

A CLOSER LOOK AT UNIVERSAL SUPPORT.

Call us today for more information about our complete line of PLD development tools and qualify for your FREE copy of the ABEL 3.0 demonstration disk. Your PLDs will be off to a better start and a faster finish.



1-800-247-5700
Ext. 315

FutureNet

A Division of Data I/O Corporation

DATA I/O

Corporation

CIRCLE NO 267

EDN August 18, 1988

VP/Publisher
Peter D Coley

VP/Associate Publisher/Editorial Director
Roy Forsberg

Editor
Jonathan Titus

Managing Editor
John S Haystead

Assistant Managing Editor
Joan Morrow

Special Projects
Gary Legg

Home Office Editorial Staff
275 Washington St, Newton, MA 02158
(617) 964-3030

Tom Ormond, *Senior Editor*
Joanne Clay, *Associate Editor*
John A Gallant, *Associate Editor*
Clare Mansfield, *Associate Editor*
Michael C Markowitz, *Associate Editor*
Dave Pryce, *Associate Editor*
Cynthia B Rettig, *Associate Editor*
Charles Small, *Associate Editor*
Dan Strassberg, *Associate Editor*
Chris Terry, *Associate Editor*
Valerie Lauzon, *Staff Editor*
Helen McElwee, *Staff Editor*
Julie Anne Schofield, *Staff Editor*
Steven Paul, *Senior Production Editor*

Editorial Field Offices

Margery S Conner, *Regional Editor*
Los Osos, CA: (805) 528-0833

Doug Conner, *Regional Editor*
Los Osos, CA: (805) 528-0865

Steven H Leibson, *Regional Editor*
Boulder, CO: (303) 494-2233

J D Mosley, *Regional Editor*
Arlington, TX: (817) 465-4961

Richard A Quinnell, *Regional Editor*
San Jose, CA: (408) 296-0868

David Shear, *Regional Editor*
San Jose, CA: (408) 997-5452

Maury Wright, *Regional Editor*
San Diego, CA: (619) 748-6785

Peter Harold, *European Editor*
0603-630782
(St Francis House, Queens Rd,
Norwich, Norfolk NR1 3PN, UK)

Contributing Editors
Robert Pease, Bob Peterson,
Don Powers, Bill Travis

Editorial Services
Kathy Leonard, *Office Manager*
Loretta Curcio, Nancy Weiland,

Art Staff
Kathleen Ruhl, *Senior Art Director*
Ken Racicot, *Associate Art Director*
Chinsoo Chung, *Staff Artist*
Cathy Filipski, *Staff Artist*

Production/Manufacturing Staff
William Tomaselli, *Production Supervisor*
Donna Pono, *Production Manager*
Danielle M Biviano, *Production Assistant*
Linda Lepordo, *Production Assistant*
Diane Malone, *Composition*

Graphics Director
Norman Graf

VP/Production/Manufacturing
Wayne Hulitzky

Director of Production/Manufacturing
John R Sanders

Business Director
Deborah Virtue

Marketing Communications
Janice Molinari, *Director*
Anne Foley, *Promotion Manager*
Sara Morris, *Promotion Assistant*

EDITORIAL

61

International trade problems may force us to give our Asian trade partners a taste of their own medicine.

NEW PRODUCTS

Components & Power Supplies	231
Computers & Peripherals	246
Integrated Circuits	258
Test & Measurement Instruments	270
CAE & Software Development Tools	283

PROFESSIONAL ISSUES

323

Design firms: A little bit of engineering heaven.—*Deborah Asbrand, Associate Editor*

LOOKING AHEAD

355

Manufacturers praise JIT logistics...\$20B market predicted for smart network equipment.

DEPARTMENTS

News Breaks	21
News Breaks International	24
Signals & Noise	32
Calendar	52
Readers' Choice	128
Leadtime Index	134
Literature	303
Software Review	314
Book Review	319
Career Opportunities	330
Business/Corporate Staff	348
Advertisers Index	350

SIEMENS

How long would it take you
to program this formula?

$$i_{rms} = \sqrt{\frac{1}{T} \int_0^T i^2 dt}$$



Just seconds... with PCI-SNAP!



Now, there's a signal analysis package available for our new PC measurement instruments. We call it PCI-SNAP, and it reads PC measurement data in ASCII format.

For the mathematical evaluation of measurement curves, PCI-SNAP features a unique aid: the **formula editor**. With its help, you no longer need to program in order to profit from the PC instrument's computing power. Step-by-step formula editing and later retrieval via a mouse is enough. The results can be displayed as a curve on a plotter or printer, for GEM™ Draw and Ventura Publisher™, and in DIF for Lotus Symphony™ and many other software packages.

We've prepared a **demo diskette**... so that you can experience the snap behind PCI-SNAP at no extra charge. Just mail us the attached coupon.

**Measurement's never been easier.
With PC instruments from Siemens.**

**Please send me your information
packet and PCI-SNAP demo
diskette right away!**

(Runs on IBM AT compatible systems
with 640 kbyte, mouse, and GEM™).

Mail to:
Siemens AG
Infoservice 213-Z178 eN
P.O. Box 2348, D-8510 Fürth

or contact your local Siemens office

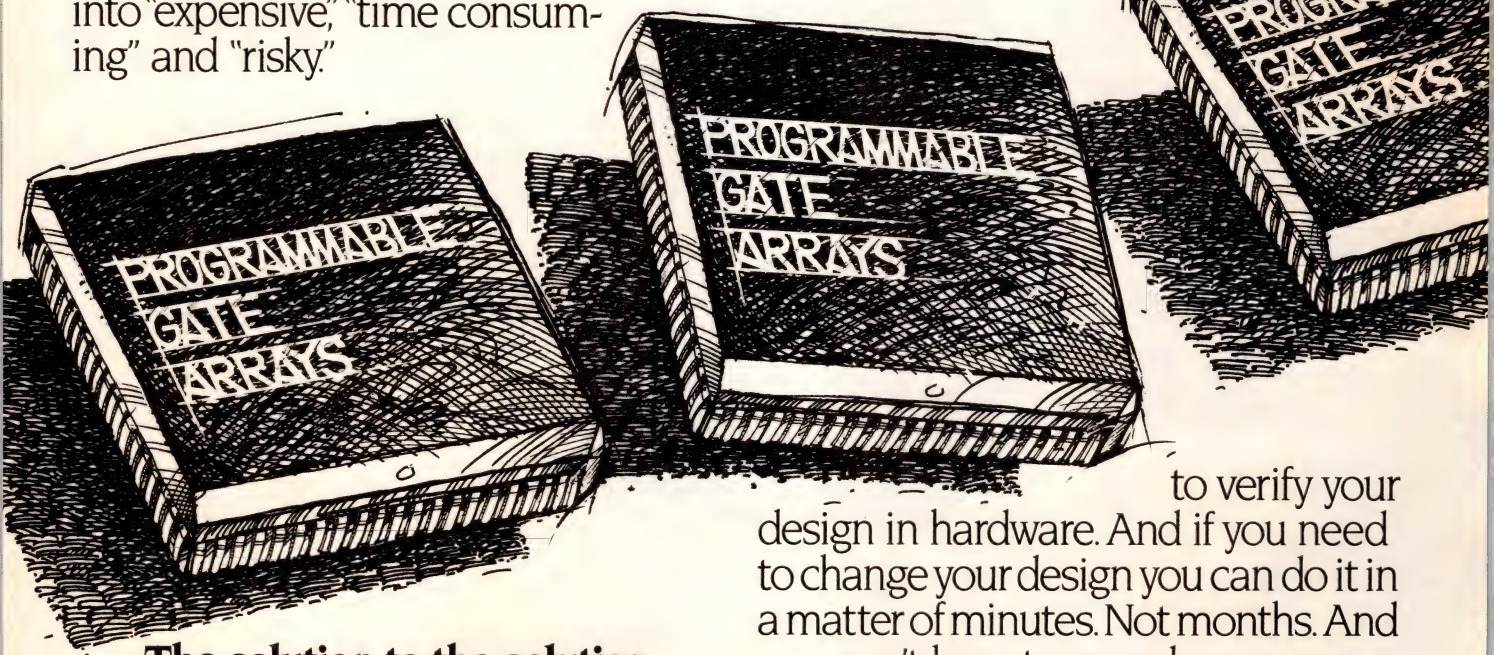
A 19100-E 686-Z9-V1-7600

CIRCLE NO 31

No one can solve but we solve

Everyone thought gate arrays would be a great solution to their semi-custom design needs. Then they designed one and discovered that "semi-custom" translated into "expensive," "time consuming" and "risky."

PGAs let you spot system problems before they become a real headache. No more risking large sums of money and time



The solution to the solution.

Meet the Logic Cell™ Array—the first Programmable Gate Array. It's a high density CMOS chip of unmatched technology that's user programmable where it's easiest for you to program—in software.

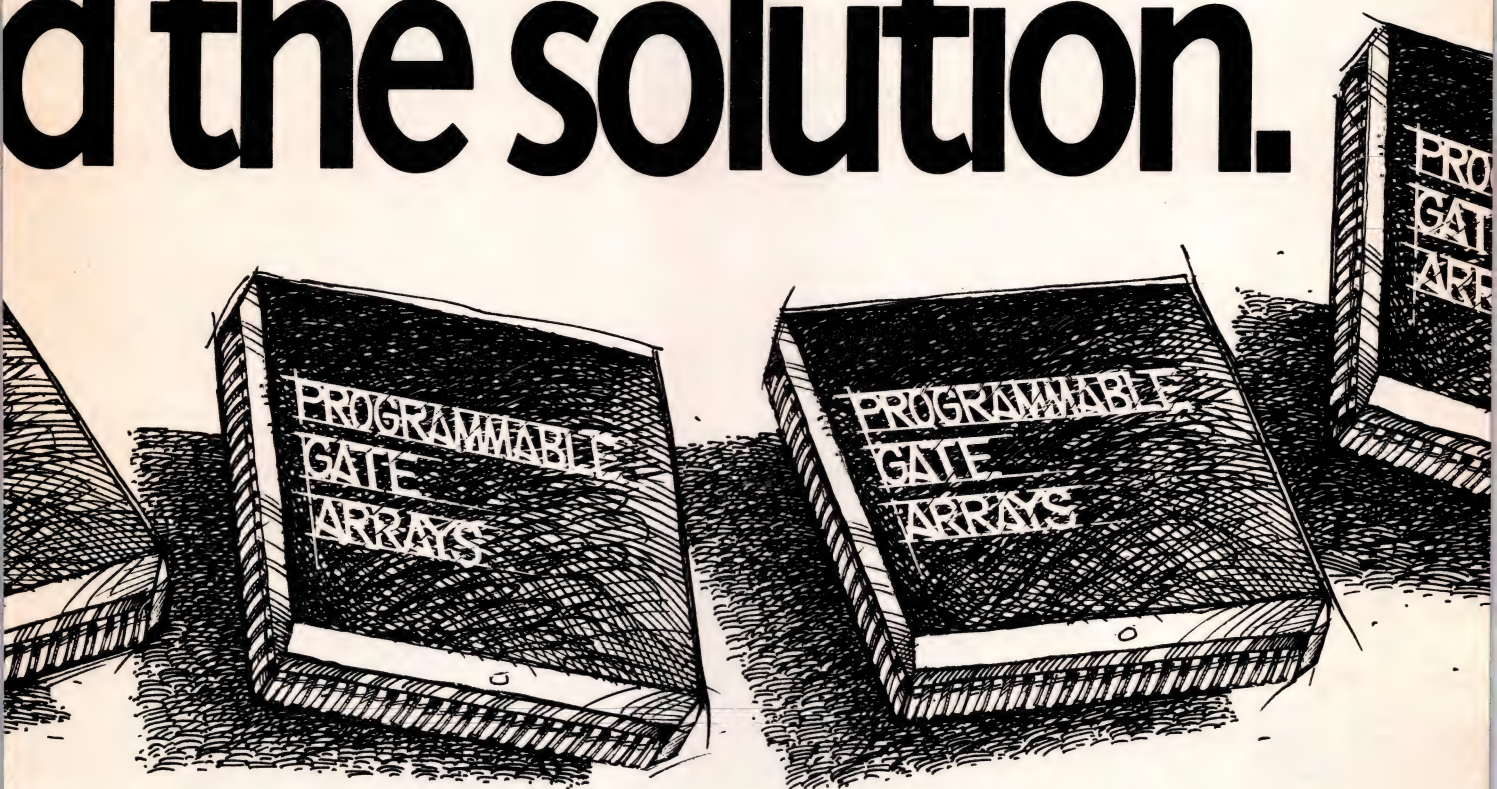
Your development cycle is cut to a week or two instead of six months. So you can get your product to market that much sooner.

to verify your design in hardware. And if you need to change your design you can do it in a matter of minutes. Not months. And you won't have to spend any more money.

9000 ways to get ahead of schedule.

The Am2000 series has densities from 1000 to 2000 usable gates and the Am3000 series has densities from 2000 to 9000 usable gates. With those densities (we'll have even higher densities later), you need fewer parts to get the same functions as

ve the problem, d the solution.



EPLDs or discrete logic.

There is no other PGA technology available today. And over 5000 designers are already using it.

Even getting started is easy.

Your investment is minimal. You don't have to finance months of NRE. You can get started for the price of a PC (which you probably already have) and some software.

PGAs are the epitome of the just-in-time product. They are the only gate arrays stocked in production quantities at your distributor. And they're programmable instantly. Which means you can go from design to production as fast as you need to.

Even overnight.

See for yourself.

Contact us for a free diskette that gives you a detailed product overview, an interactive session where you can plug in your own design criteria and find out how PGAs can help your design. Part of the PGA development software is included so you can get started saving time and money right away.

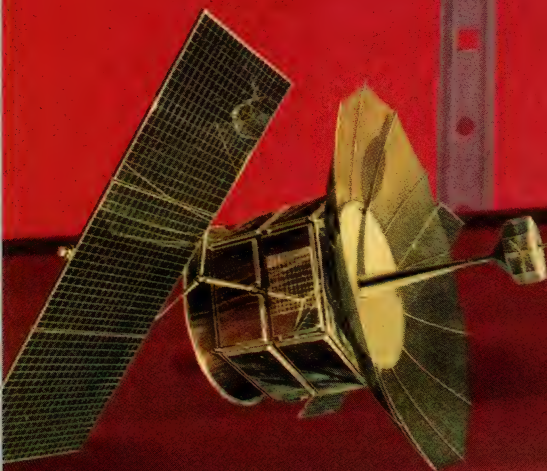
Advanced Micro Devices

Just drop us a line.

Simply write "PGA" on your letterhead and send it to:
P.O. Box 4, Westbury-on-Trym, Bristol BS9 3DS, United Kingdom.

Bruxelles (02-2) 771 91 42 • Hannover area (0511) 73 60 85 • Hong Kong (5) 8654525 • London area (04862) 22121 • Manchester area (0925) 828008 • Milano (02) 3533241 • München (089) 41 14-0 • Osaka (06) 243-3250 • Paris (1) 49 75 10 10 • Seoul (02) 784-7598 • Singapore (65) 225 7544 • Stockholm (08) 733 03 50 • Stuttgart (0711) 62 33 77 • Taiwan (02) 7122066 • Tokyo (03) 345-8241 • Latin America, Fort Lauderdale, Florida/USA: Tel: (305) 484-8600 Tlx: (510) 955-4261 and ftd
© 1988 Advanced Micro Devices, Inc. Logic Cell is a trademark of Xilinx, Inc.

We have solutions to your
toughest microcircuit prob



lements...

And many are coming right off our shelves.

For over twenty years, CTI has been providing design and manufacturing solutions for some of the most complex black box requirements in the most demanding markets—military and government, avionics, telemetry, navigation, communications, guidance and control systems, among others.

Our products range from custom hi-rel hybrid microcircuits, to Standard Electronic Modules (SEMs) in high-density configurations, to miniaturized subsystems for military and space applications. We have in-house hybrid and monolithic design, manufacturing, and technology expertise to convert the toughest requirements into high-performance microcircuits.

And we've used our experience to build a host of standard circuits. These pre-engineered "off-the-shelf" packages include MIL-STD-1553 standard data bus products, and MIL-STD-1397 interfaces.

One new standard product is the CT2100,

a microprocessor controlled, quad solid state relay, with 1500 volt isolation. The circuit incorporates fully isolated switch status and built-in test functions, and operates from -55 to +125°C in military environments.

So, whether your project is in the early design stage or is approaching production, call on CTI.

Solutions to some of your requirements may have to be invented. Others may already be on our shelves. We offer you the advantage of either—or both. Call or write us today.



CTI

Circuit Technology Inc.

160 Smith Street, Farmingdale, New York 11735

Tel: (516) 293-8686 Fax: (516) 293-8622

CIRCLE NO 28



Only HP can put real teeth into faster

Test development and execution speed. We know they're your top priorities. HP BASIC,* combined with our range of controllers and instrumentation, is the answer. Even if you're running on MS™DOS or the UNIX™ operating system. And of course, it's all backed by HP's measurement expertise, and the product reliability you've come to count on from an industry leader.

HP BASIC: Optimized for instrument control.

It's no secret that a critical element of automated instrument control is fast development time. That's where HP BASIC really shines. With power, versatility and ease of use. We invite you to find a better instrument control language.

A few examples:

- Fast program development with interactive editing, syntax checking and the ability to search and replace

strings, or move blocks of code easily.

- Optimized for I/O with advanced constructs to simplify otherwise complex tasks. Interrupts, high speed data transfers, automatic data formatting and branching on events can all be handled easily. Since HP BASIC was designed for instrument control, these capabilities are integral, not tacked on as an afterthought.

- Structured programming lets you make your program modular with independent subprograms which can be re-used in other applications. Constructs like CASE statements, IF-THEN-ELSE, WHILE, REPEAT-UNTIL and LOOP are useful for rapid program development and invaluable for program maintenance.

- Powerful computation lets you take advantage of a full range of matrix manipulations such as multiplication, inversion and scalar operations. HP's complex number implementa-

tion allows for powerful arithmetic operations.

- Graphic capabilities are simple to program, yet powerful. One program statement can draw axes or grids, a second will plot your data, a third will label your plot and a fourth will provide a permanent copy.

HP Controllers: The right horsepower for the job.

Hewlett-Packard provides a wide range of instrument controllers and operating systems to meet your performance needs, allowing you to choose the most cost effective controller for your job.

Just look:

- Personal computers; the HP BASIC Language Processor allows you to use HP BASIC on the world's most prevalent operating system, MS DOS. It's available for the HP VECTRA or the IBM PC-AT.

* Sometimes called Rocky Mountain BASIC or BASIC 5.0.

we never stop
asking

"What if...

test development.

- Dedicated controllers up to 4 MIPS. HP's Series 300 controllers provide a dedicated, high performance system for maximum I/O throughput.
- HP-UX workstations. HP BASIC will also be available for use in the Series

**Trim more time:
Deal with the pros.**

Our sales, service and support team can get your test up and running when time is of the essence. With over

500 instruments, HP is the recognized industry leader in test and measurement.

**Call HP for
a free video.
1-800-752-0900,
Dept 215R**



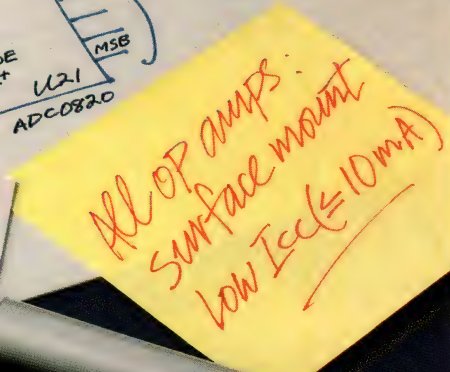
300 HP-UX environment. Our implementation combines the ease-of-use and performance of HP BASIC with the full networking, multitasking and windowing capabilities of the UNIX operating system.

No matter the controller demand, HP makes it in the optimum package.

Ask for our free videotape on HP BASIC or a brochure on HP instrument controllers. Learn how Hewlett-Packard can help you cut test development time significantly.

© 1988 Hewlett-Packard Co. EI 15814/EDN

hp HEWLETT
PACKARD



LM6161/LM6261/LM6361
High Speed Operational Amplifier

General Description
The LM6161 family of high-speed amplifiers exhibits an excellent speed-power product in delivering 300 V/ μ s and 50 MHz unity gain stability with only 5 mA of supply current. Further power savings and application convenience are possible by taking advantage of the wide dynamic range in operating supply voltage which extends all the way down to ± 5 V.

These amplifiers are built with National's new VIP™ (Vertically Integrated PNP) process which provides fast PNP transistors that are true complements to the already fast NPN devices. This advanced junction-isolated process delivers high speed performance without the need for complex and expensive dielectric isolation.

- High slew rate
- High unity gain freq
- Low supply current
- Fast settling
- Low differential gain
- Low differential phase
- Wide supply range
- Stable with unlimited capacitive
- Well behaved; easy to apply

Step Response; $A_v = +1$



© 1994 National Semiconductor Corporation

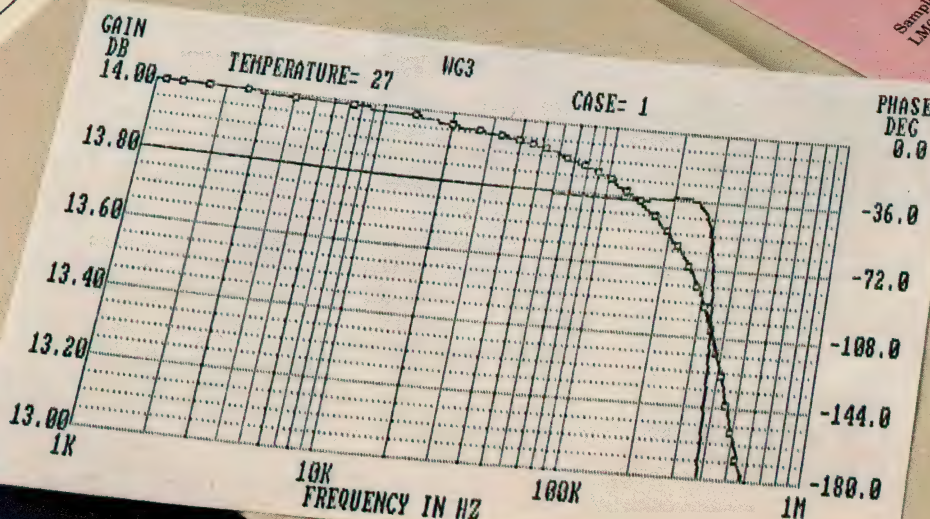
007 National Semiconductor Corporation TL/H/9057

PRELIMINARY
June 1987

970186

**HIGH SPEED
OP-AMPS**

"VIP" PROCESS



Sample
LM6361

APPLICATIONS

- Video
- LAN

Everything you need to design-in high-speed op amps. For the price of a stamp.

OUR NEW VIP™ OP AMPS MAKE DESIGNING EASIER

Built with National's exclusive vertically integrated PNP (VIP) process, these new amplifiers couldn't be easier to design with—even for the novice.

You can use them to develop new designs never before practical. Or to enhance old designs for very little cost—in dollars, power, or real estate.

And we'll send you everything you need to get started—including a free sample. So you can see for yourself just how easy it is.

HIGHER SPEEDS, LESS POWER

These new op amps feature slew rates of 300 V/μs and gain-bandwidth products up to 750 MHz.

And they do so without complex, expensive, and power-hungry dielectric isolation techniques.

© 1988 National Semiconductor Corporation

VIP op amps require no more power than traditional op amps. You can even use the same type of circuit-building techniques—with very little supply bypassing.

Because of their unique low power dissipation, you can easily fit them into predominantly digital systems without special analog power supplies.

Our exclusive VIP process and device layout give them excellent stability. They'll drive a 330 pF capacitive load—or any other size—with no oscillation.

The LM6361 is unity gain stable, the LM6364 stable for gains above 5, and the LM6365 for gains above 25. We also offer two VIP buffers.

LOWER COST

Not only are VIP op amps easier to design with than comparable devices but they cost less than a fourth as much. They are not made with expensive processes. Nor are they packaged in expensive packages.

Instead of TO-3s, they are packaged in ordinary 8-pin mini-DIP or surface-mount packaging.

They're ideal for video output stages, data communication systems, graphics systems, local area networks, and sample-and-hold circuits.

MORE CHOICES

In addition to VIP, National offers no less than four other major op amp processes—bipolar, BI-FET®, CMOS, and hybrid. And each category contains many variations and subprocesses, so that you can choose the optimum building blocks for your application.

SEND FOR YOUR FREE SAMPLE KIT TODAY

All you have to do to get your free VIP sample kit is to return the coupon below. Or—if you don't have the price of a stamp—simply give us a call, toll-free, at (800) 252-4488, ext. 732.



CIRCLE NO 33

Please send me my free VIP sample kit with comprehensive data.

Name _____ Title _____
Company _____ Phone _____
Address _____
City _____ State _____ Zip _____

ADTL03 FK12000 EDN

Mail to National Semiconductor Corporation, Inquiry Processing Center,
P.O. Box 6458, Torrance, CA 90504-9953.

wasatch

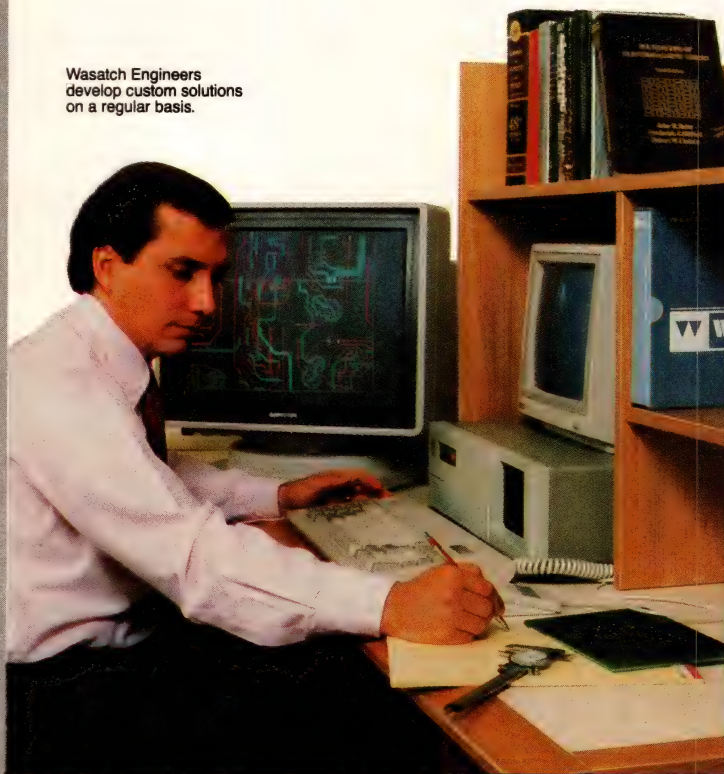
HIGH VOLTAGE, INC.

A COMMITMENT TO "NO PROBLEM" POWER.

Over seven years of growth with a commitment to "problem free" design and manufacturing has brought Wasatch to the forefront of High Voltage Power. Today we are one of the largest suppliers of CRT power supplies. In fact, it's very difficult to find a company that's more capable of modifying or customizing power supplies to fit your specific application, deliver units at low cost, and provide "just-in-time" deliveries.

High Voltage Power, No Problem...
it's the reason why Wasatch is the right choice for your high voltage needs.

Wasatch Engineers
develop custom solutions
on a regular basis.



Rep Inquiries Welcome

CIRCLE NO 35

Need A Custom Unit?... No Problem.

On a regular basis, Wasatch Engineers work directly with the customer to turn standard power supplies into prototypes for specific applications. And if a specific "off-the-shelf" unit cannot be modified, we'll design an entirely new unit at a very reasonable cost. So give us your idea, and watch us develop a prototype.

Need Quick Turnaround?... No Problem.

Prototypes can be delivered as soon as ten days after placing an order. We will even design products to fit your own manufacturing needs, and provide "just-in-time" deliveries to help control your inventory.

Need Reliability?... No Problem.

Wasatch units are subjected to stringent quality control. All units feature 48 hour burn-in and are backed by a full one year warranty.

Need Low Cost?... No Problem.

Wasatch is a company small enough to meet your needs, yet large enough to stay cost competitive. It's difficult to find a vendor that offers more power supply for your dollar.

So try the advantage of "No Problem" high voltage power. If you compare, you'll find Wasatch offers a product line that is unparalleled in reliability, turnaround, and price.

Call us for an estimate today.



Custom and semi-custom units are available.

wasatch

High Voltage Inc.
4100 South West Temple
P.O. 15457
Salt Lake City, Utah 84115
1-801-265-9561

NEWS BREAKS

EDITED BY JOANNE CLAY

MOSFET COMBINES HIGH POWER WITH LOW DRIVE REQUIREMENTS

The APT5010FN, a 500V power MOSFET from Advanced Power Technology (Bend, OR, (503) 382-8028), delivers 50A of usable current and features input capacitance of 6000 pF—about half the drive requirement of conventional MOSFETs configured for comparable currents, according to the manufacturer. Designed for power-supply and motor-control circuits in military and commercial systems, the device features 0.1Ω on-resistance. The MOSFET is fabricated on a 338×588 -mil die and is available in a hermetically sealed package and in a die version (APT5010DN). The units are available with full military screening. The packaged and die versions cost \$149.88 (1000) and \$66.20, respectively. Delivery is four to six weeks.—Tom Ormond

POWER RECTIFIERS FEATURE 50-NSEC RECOVERY TIME

The 5A USC130X power rectifier from Semtech (Newbury Park, CA, (805) 498-2111) features a 50-nsec reverse recovery time at 200V, 300V, and 400V. (The X in the part number can be 4, 5, or 6, designating 200V, 300V, or 400V, respectively.) The hermetically sealed, subminiature, axially leaded parts are also available in a 2A version, the USC110X. Prices start at \$4 (OEM qty).—Margery S Conner

RF GENERATOR SENDS LONG-WAVE SIGNALS THROUGH UHF

Priced at only \$195 and providing an output range from 100 kHz to 150 MHz, the Model 2005 RF Signal Generator from B&K Precision (Chicago, IL, (312) 889-1448) offers you six fundamental bands and 450 MHz on harmonics. You can modulate the amplitude of the generator's output via an internal 1-kHz source, or you can do it externally by using any audio frequency. The 2005 can perform step and variable output attenuation to 40 dB, as well as variable amplitude modulation from 0 to 100%. The unit has a separate output for an external frequency counter and an RF connection. An antibacklash vernier dial gives you output-frequency control to within 3%.—J D Mosley

JFET OP-AMP FAMILY YIELDS HIGH SPEED AND LOW POWER

Texas Instruments' (Dallas, TX, (800) 232-3200) TL050 Enhanced-JFET op amps reduce input-offset voltage (V_{IO}) shifts to 60 μ V (typ) without resorting to metal packaging. They provide higher slew rates and lower input-bias-current requirements than do standard bipolar devices. The devices are pin-compatible with industry-standard JFET op amps, and you can choose a 15 or 2V/ μ sec minimum slew rate with a maximum V_{IO} ranging from 0.8 to 4.0 mV.—J D Mosley

8-BIT HALF-FLASH ADC INCLUDES TRUE SAMPLE/HOLD AMPLIFIER

The LTC1099 from Linear Technology Corp (Milpitas, CA, (800) 637-5545) is a half-flash 8-bit A/D converter that converts in 2.5 μ sec. A true sample/hold amplifier is included on the chip; it allows the ADC to convert 5V p-p signals at as much as 167 kHz, or signals with slew rates as high as 20V/ μ sec. The LTC1099 is pin compatible with the AD7820 and the ADC0820; these older devices can complete the A/D conversion in 1.5 μ sec, but have pseudo-S/H amplifiers that can accept signals with a maximum slew rate of 0.1V/ μ sec or a bandwidth limit of 7 kHz. (To acquire signals with higher frequencies, these older devices require an external S/H amplifier, which is usually expensive.) The LTC1099 costs \$8 (100).—David Shear

NEWS BREAKS

VME BUS SINGLE-BOARD COMPUTER INTEGRATES PERIPHERAL CONTROL

The Liberator-SBC single-board VME Bus computer is the only one to include so many functions on a single board, claims its vendor, Integrated Solutions (San Jose, CA, (408) 943-1902). Other products require as many as five boards to implement the same functions. The board includes a 16- or 20-MHz 68020 coupled with a 68851 paged memory-management unit and a 68881 floating-point unit. Its memory comprises 4M bytes of 1-wait-state RAM, 64k bytes of 2-wait-state EPROM, and 32 bytes of EEPROM. The board also includes an Ethernet interface, two synchronous/asynchronous serial ports, a synchronous or asynchronous SCSI port, 1024×768-pixel graphics with 16 colors, an 8-bit DAC with a 20-kHz bandwidth, and a battery-backed clock/calendar function. The board costs \$5995.—Doug Conner

STANDARD CREATES SET OF COMMON CALLS FOR 88000 OPERATING SYSTEMS

A trial-use binary compatibility standard (BCS) published by the 88open Consortium Ltd (Stratham, NH, (603) 778-3001) establishes a common set of basic, system-level calls for executable and binary programs written for systems based on Motorola's 88000 μ P. The 66 BCS calls define standard services an operating system can provide to an application program, including file I/O, process creation, and interprocess communications. The consortium's BCS defines a subset of calls taken from AT&T's proposed Unix application binary interface (ABI); AT&T has informally indicated to the 88open BCS committee that it intends to use the BCS as the basis for an 88000- μ P Unix ABI. Copies of 88open's BCS publication cost \$100.—Steven H Leibson

FLOATING-POINT MATH CHIP HELPS BREAK I/O BOTTLENECKS

The ADSP-3264 64-bit floating-point math chip from Analog Devices (Norwood, MA, (617) 329-4700) will incorporate an architecture that permits either eight 32-bit or four 64-bit internal data transfers per cycle. The transfers involve moving data to and from an internal register file, an arithmetic-logic unit (ALU), and a multiplier-divider unit. Packaged in a 280-pin ceramic pin-grid array (PGA), the chip will run at 15.6 MHz. That clock frequency translates into a 31M-flops rate—one floating-point operation per clock cycle in the ALU and one operation in the chip's multiplier. A 64-bit double-precision division operation requires 768 μ sec.

The chip performs standard IEEE-754 single- and double-precision floating-point math operations as well as 32-bit 2's-complement and 32-bit unsigned fixed-point manipulations. Samples are \$545 (1000); they should be available in October. The manufacturer expects to offer production quantities during the second quarter of 1989.—Jon Titus

PLD-DEVELOPMENT TOOL GETS NEW PRIMARY SOURCE

CUPL, the PLD-development software heretofore marketed by Personal CAD Systems, is now a product of Logical Devices Inc (LDI) (Fort Lauderdale, FL, (305) 974-0975). LDI will assume all of P-CAD's existing CUPL maintenance agreements. CUPL, which lists for \$1250, runs under MS-DOS, Unix, and VMS.—Dan Strassberg

DIGITAL ENCODERS PROVIDE DIRECT μ P INTERFACE

Available in 2-, 4-, or 5-bit versions, the EV and EH Series encoders from Allen-Bradley (El Paso, TX, (800) 592-4888 or (800) 292-4888) may eliminate the need for A/D conversion in your design application. The devices offer panel potentiometer capabilities, continuous rotation, and as many as 36 electrical positions per revolution; they range in price from \$1.39 to \$1.51 (1000).—J D Mosley



Products of Your Environment.

A field-use fiber optic connector so tough, you could roll a 5 ton truck over it. A Parallel Interconnect that allows a gas-tight interface in 60 seconds flat. A cabling assembly enabling a single connector to handle electronic signals, fiber optics *and* power supply.

These are but a few innovations in interconnections from ITT Cannon. But we couldn't have done it without you. Because success throughout our company relies on a thorough knowledge of your company's environment.

Take strategic partnering, for example. We don't create a custom solution by shaking your hand and jotting down a few notes. When we design-in, we get *inside* your environment.

Then there's Cannon's near-zero defect rate. It got that way, and stays that way, because we test each product in a carefully simulated environment.

As for delivery, we built a dependable system by studying the needs and scheduling realities of our customers' business environments worldwide.

And Cannon stays price competitive by always asking the question, "How will this connector be used?" Considering the connector's ultimate environment has taught us that keeping quality high ends up costing our customer less.

So if you'd like a partner who will take the time to learn about your environment, take a moment to contact ITT Cannon at (714) 964-7400.

Worldwide Headquarters
10550 Talbert Ave.
Fountain Valley, CA 92708
Or call (714) 964-7400

ITT CANNON

*We're making progress.
Not excuses.*

CIRCLE NO 36

NEWS BREAKS: INTERNATIONAL

RF MOS POWER TRANSISTORS OUTPERFORM BIPOLAR TYPES

Offering significant performance advantages in comparison with high-frequency bipolar power transistors, the BLF series of MOS power transistors from Philips Components Div (Eindhoven, The Netherlands, TLX 51573) is suitable for use in the output stages of HF and VHF transmitters. In the near future, the company plans to extend the range with power transistors that can operate at UHF.

Among the currently available transistors are devices with power ratings of between 2 and 300W. These transistors feature noise figures in duplex mode that are typically 7 dB less than those of bipolar types, and they offer power gains that are as much as 4 dB higher than bipolar types. In addition, it's easier to control the power level of a MOS transistor because you can do so simply by altering the device's gate bias voltage. MOS transistors are also more reliable than bipolar types. Their negative drain-current temperature coefficient eliminates thermal runaway problems and allows you to parallel devices without incurring current-sharing problems. In addition, the MOS devices have greater tolerance of load mismatch (lower-power devices withstand an all-phases VSWR as high as 50:1 at full rated power without damage), and they have less of a tendency toward parasitic oscillation. The BLF145, an 8W, 28-MHz device in a SOT-123 package, sells for around gld 60 (100).

—Peter Harold

DEMAND FOR DRAMs EXPECTED TO SHIFT FROM 256k- TO 1M-BIT PARTS

The Japanese Ministry of International Trade and Industry (MITI) has reportedly predicted a decline in the demand for 256k-bit dynamic RAMs for the third quarter of 1988. The demand is expected to drop 1% from the second-quarter figure. Meanwhile, MITI also predicted a big increase in the demand for 1M-bit dynamic RAMs. The 40-million-part demand projected for the second quarter is expected to swell to almost 53 million pieces in the third quarter. The ministry expects another 35% increase in demand for the 1M-bit parts and another 3.3% drop in demand for the 256k-bit DRAMs in the fourth quarter. MITI also projected that DRAMs will remain in short supply even though vendors are increasing production.—Joanne Clay

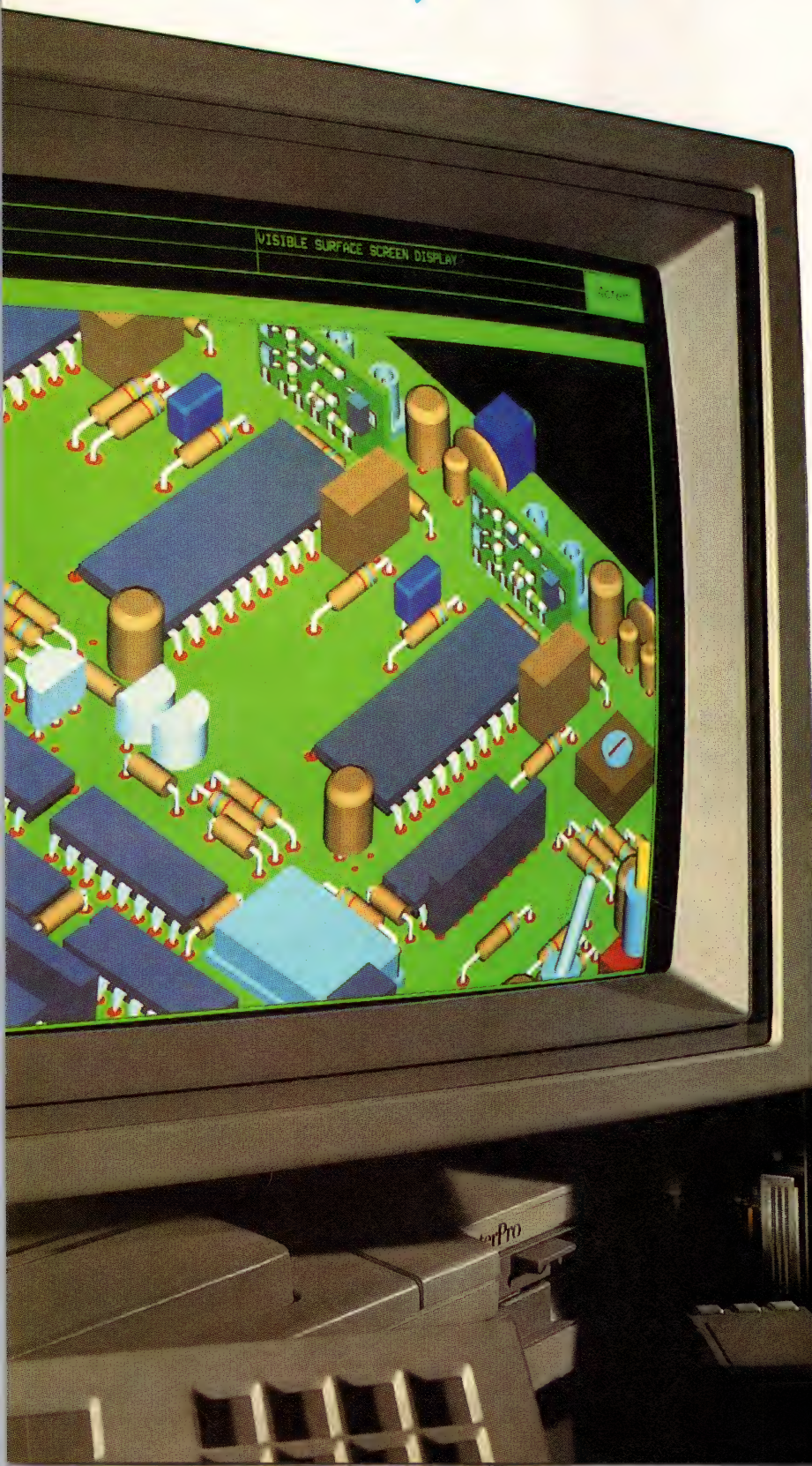
32-BIT FLOATING-POINT COPROCESSOR REACHES 6.7M FLOPS

The MuPD72691 32-bit floating-point math coprocessor from NEC can perform 6.7M flops. The chip, which is fabricated in a 1.2- μ m, double-layer-aluminum CMOS process, operates with the company's V Series 32-bit microprocessors. The device can perform high-speed arithmetic floating-point operations and matrix operations in one command, a capability that's essential for 3-dimensional-image display and manipulation. Samples of the 16-MHz device cost approximately \$615; for the 20-MHz part, the sample price is about \$769.—Joanne Clay

Simple as...

pushing a button!

Design Engineer	PCB Engineer
Hybrid Engineer	CAM Engineer
Mechanical	Analysis
Publication	Database



Intergraph makes PCB design and manufacturing easy. Our interactive graphics solutions address a wide variety of design and manufacturing methodologies. And our product interface is designed for both the beginning and the expert user.

From your workstation, simply push a button to...

- ☐ Place
- ☐ Route
- ☐ Evaluate
- ☐ Package
- ☐ Document
- ☐ Output

In short, Intergraph provides everything you need to get your products to market faster.

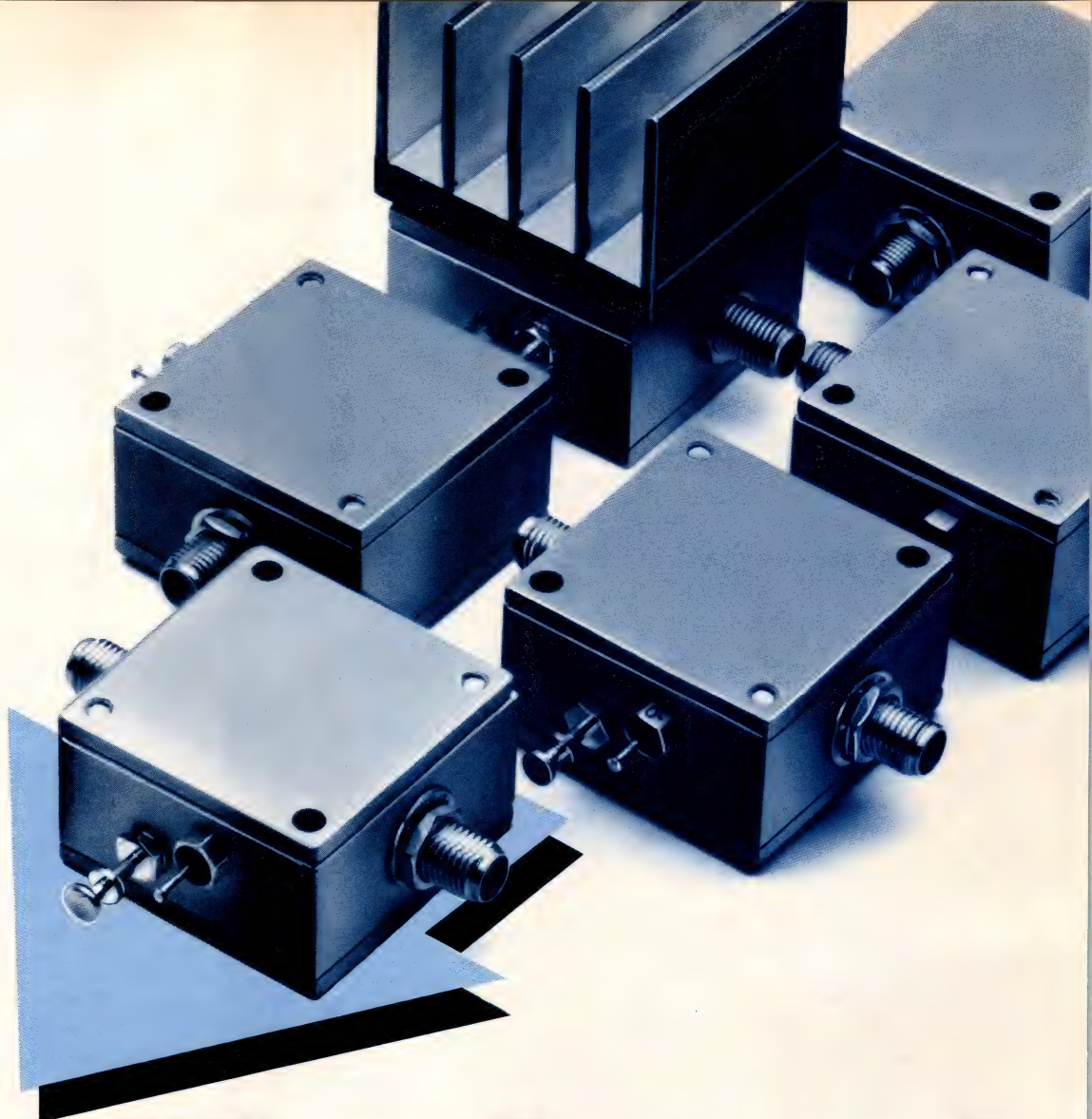
Our 5-MIPS CLIPPER workstations and servers give you the performance to handle your most difficult boards, while allowing you to pass data via Ethernet and other industry-standard networks.

To see how Intergraph can make your PCB work as simple as pushing a button, call 800-826-3515 or 205-772-2700.

CIRCLE NO 37

INTERGRAPH

Intergraph and CLIPPER are registered trademarks of Intergraph Corporation.
Ethernet is a trademark of Xerox Corporation.



Amplifier Arsenal

50KHz—2000MHz, Low Noise 250mW output Gain Controlled from \$69.95

Our ZFL-2000 miniature wideband amplifier hit a bulls-eye when we introduced it last year. Now we've added more models to offer you a competitive edge in the continuing battle for systems improvement.

The ZFL-2000, flat from 10 to 2000MHz, delivers +17dBm output and is priced at only \$219.

Need more output? Our ZFL-1000H, flat from 10 to 1000MHz, delivers +20dBm output.

Is low noise a critical factor? Our ZFL-500LN and 1000LN boast a 2.9dB NF.

Variable gain important? Our ZFL-1000G, flat from 10 to 1000MHz, delivers +3dBm output with 30dB gain control while maintaining constant input/output impedance.

Searching for a high-quality, low-cost amplifier? Our ZFL-500 flat from 50KHz to 500MHz, delivers +10dBm output for the unbelievable low price of only \$69.95. Need to go higher in frequency? Consider the ZFL-750, from 0.2 to 750MHz, for only \$74.95. Or the \$79.95 ZFL-1000, spanning 0.1 to 1000 MHz.

One week delivery...one year guarantee.

SPECIFICATIONS

MODEL	FREQUENCY MHz	GAIN, dB (min.)	MAX. POWER OUTPUT dBm(typ)	NF dB(typ)	PRICE \$ Ea. Qty.
ZFL-500	0.05-500	20	+9	5.3	69.95 1-24
ZFL-500LN	0.1-500	24	+5	2.9	79.95 1-24
ZFL-750	0.2-750	18	+9	6.0	74.95 1-24
ZFL-1000	0.1-1000	17	+9	6.0	79.95 1-24
ZFL-1000G*	10-1000	17	+3	12.0	199.00 1-9
ZFL-1000H	10-1000	28	+20	5.0	219.00 1-9
ZFL-500HLN	10-500	19	+16	3.8	99.95 1-24
ZFL-1000LN	0.1-1000	20	+3	2.9	89.95 1-24
ZFL-1000VH	10-1000	20	+25	4.5	229.00 1-9
ZFL-2000	10-2000	20	+17**	7.0	219.00 1-9

* 30dB gain control ** +15dBm below 1000MHz

finding new ways...
setting higher standards

Mini-Circuits

A Division of Scientific Components Corporation
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500
Fax (718) 332-4661 Domestic and International Telexes: 6852844 or 620156



value-packed filters **\$995** from

dc to 3GHz

- less than 1dB insertion loss over entire passband
- greater than 40dB stopband rejection
- 5 section, 30dB per octave roll-off
- VSWR less than 1.7 (typ)
- over 100 models, immediate delivery
- meets MIL-STD-202
- rugged hermetically sealed package (0.4 x 0.8 x 0.4 in.)
- BNC, Type N, SMA available

finding new ways ...
setting higher standards

Mini-Circuits

A Division of Scientific Components Corporation
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500
Fax (718) 332-4661 Domestic and International Telexes: 6852844 or 620156

LOW PASS	Model	*LP-	10.7	21.4	30	50	70	100	150	200	300	450	550	600	750	850	1000
Min. Pass Band (MHz) DC to	10.7	22	32	48	60	98	140	190	270	400	520	580	700	780	900		
Max, 20dB Stop Frequency (MHz)	19	32	47	70	90	147	210	290	410	580	750	840	1000	1100	1340		

Prices (ea.): P \$9.95 (6-49), B \$24.95 (1-49), N \$27.95 (1-49), S \$26.95 (1-49)

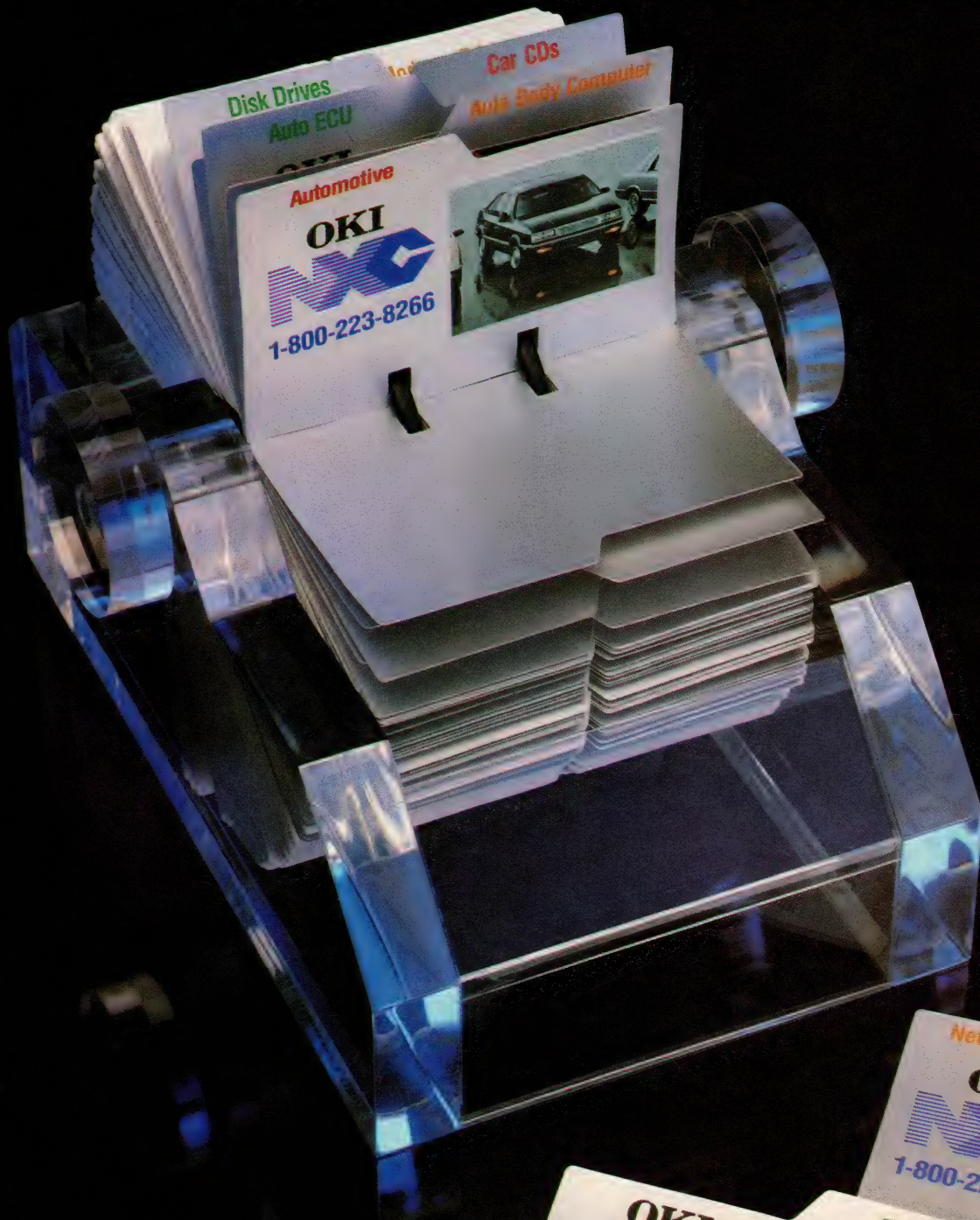
HIGH PASS	Model	*HP-	50	100	150	200	250	300	400	500	600	700	800	900	1000
Pass Band (MHz)	start, max.	41	90	133	185	225	290	395	500	600	700	780	910	1000	
	end, min.	200	400	600	800	1200	1600	1600	1600	1600	2000	2100	2200		
Min. 20dB Stop Frequency (MHz)		26	55	95	116	150	190	290	365	460	520	570	660	720	

Prices (ea.): P \$12.95 (6-49), B \$27.95 (1-49), N \$30.95 (1-49), S \$29.95 (1-49)

*Prefix P for pins, B for BNC, N for Type N, S for SMA [example: PLP-10.7](#)

C105 REV.D

The Great 16-bit Solution!





the first core-based 16-bit CMOS MCU.

From OKI system technologies, the solution for high-end multitasking applications.

Call on OKI **NXC**, and you move that tough multitasking application into the next generation of microcomputing. It's the performance of tomorrow — available today, with OKI's new 66301 MCU. The industry's first core-based 16-bit CMOS controller. Our first **NXC** solution.

OKI system technologies have implemented a true macro-cell approach with the 66301. Essentially a static part, this MCU presents a whole new level of integration. On board, in addition to the 16-bit CPU: 16K bytes of ROM (48K bytes external). 512 bytes of built-in RAM (512K bytes external).

You also get four 16-bit timers, 2 PWMs, plus a watchdog timer. And a rich range of instructions, including special instruc-

tions for word-length multiplication and division.

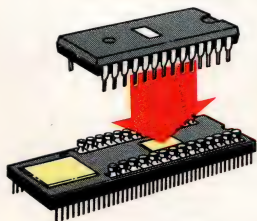
Now add in an 8-channel, 10-bit A-D converter and a baud rate generator, with variable bit length operations and context switching. On a single chip, our revolutionary macro-cell design packs far more options, capabilities and sophisticated functions than any 16-bit industry standard can now offer.

With the 66301 on line (and an E² version available soon), OKI's exclusive **NXC** introduces a new generation of high-level integration — for your most demanding automotive, telecomm and instrumentation system requirements.

16-bit development solutions

OKI's total commitment to development ease and support gives you a headstart in **NXC** microcomputing.

We can provide a special development version of the 66301 chip — built to accept an EPROM piggyback. To check out your design in realtime, snap on your coded memory. This allows you to keep burning code variations into inexpensive EPROMs, until you get a working prototype ...at a very minimal cost.



Of course, OKI's 66301 MCU is solidly backed with a full-scale development system. For realtime in-circuit emulation (ICE), use the **NXC** EASE system. The portable EASE package includes your ICE hardware,

user's manual, plus complete assembler and debugger software for both MSDOS and VMS. With a compatible high-efficiency C-Compiler option as well. All available from OKI. All part of the **NXC** solution to high-end multitasking applications, produced by the most system-oriented technologies in the field today.



16-bit Solutions — on call.

- () Please send complete technical data on the NXC 16-bit CMOS MCU solution produced by OKI system technologies.
- () Call me, I have immediate requirements.
Tel: (____) _____

Name _____

Title _____

Company _____

Please clip coupon to business card or letterhead and return to: **NXC Customer Service, OKI Semiconductor**, 650 N. Mary Ave., Sunnyvale, CA 94086. (408) 720-1900.

EDN081888

OKI

SEMICONDUCTOR

CIRCLE NO 38

Get your off to a run



© 1988 Force Computers, Inc.
Running Start and VME/PLUS are trademarks of Force Computers, Inc. UNIX is a trademark of AT&T. VxWorks is a trademark of Wind River Systems, Inc. pSOS is a trademark of Software Component Group, Inc.
VRTX32 is a trademark of Ready Systems, Inc. C EXECUTIVE is a trademark of JMI Software Consultants, Inc.

VME project ning start.

Introducing Running Start™ from Force Computers.

It's a package deal.

The deal: Now you can integrate your VME hardware and software in a fraction of the time it used to take. And start writing application software months ahead of your competition.

The package: Running Start, the first integrated software development package for VME. And the perfect complement to our VME/PLUS™ line of high performance products.

Running Start comes complete with board I/O drivers, diagnostic and test code and complete documentation. More importantly, you also get a consistent programming interface across the Force VME line.

With Running Start you can integrate your target system with our VMEPROM software, a real-time, multi-tasking kernel resident in EPROM. It makes your user programs completely compatible with other Force VME boards. Best of all, with VMEPROM, there's no license and no extra charge.

With Running Start and your favorite development environment, such as PCs or UNIX workstations, you can quickly develop your applications with VMEPROM and third-party software, including VxWorks, pSOS, VRTX32 and C EXECUTIVE.

Thanks to all these options, it's unlikely you'll ever again be bogged down with integration problems. But if you are, there's a whole team of Force engineers waiting to help.

So put your project on the fast track. Call 1(800)BEST-VME and find out more about VME/PLUS and Running Start. And don't forget to ask for our Running Start data sheet and 1988 data book.



VME at its best.

FORCE COMPUTERS, INC.
3165 Winchester Blvd.
Campbell, CA 95008-6557
Telephone (408) 370-6300
Telefax (408) 374-1146

FORCE COMPUTERS, GmbH
Daimlerstrasse 9
D-8012 Ottobrunn
Telefon (089) 60091-0
Telex 524190 forc-d
Telefax (089) 6 097793

SIGNALS & NOISE

Swap amplifier leads to make thermocouple work

I'd like to correct some errors in the schematic I submitted with the Design Idea "Electronic thermometer has 10-mV/°F output" (EDN, April 28, 1988, pg 237). To make the thermocouple thermometer work correctly, you must swap the leads to the amplifier: You hook the thermocouple lead to pin 3 and connect the other wire from the bridge circuit to ground. The accompanying figure shows a corrected version of the circuit.

If you reduce the gain of the amplifier to 100 (by changing R_2 from 1 M Ω to 100 k Ω), the output of the thermometer will be 1 mV/°F, so the thermometer will be able to read temperatures as high as 1800°F. Note, however, that there will be a 2% error in the temperature readings above 660°F.

Bill Donofrio

Moore Research Center
Grand Island, NY

Self-modifying code poses unacceptable risk

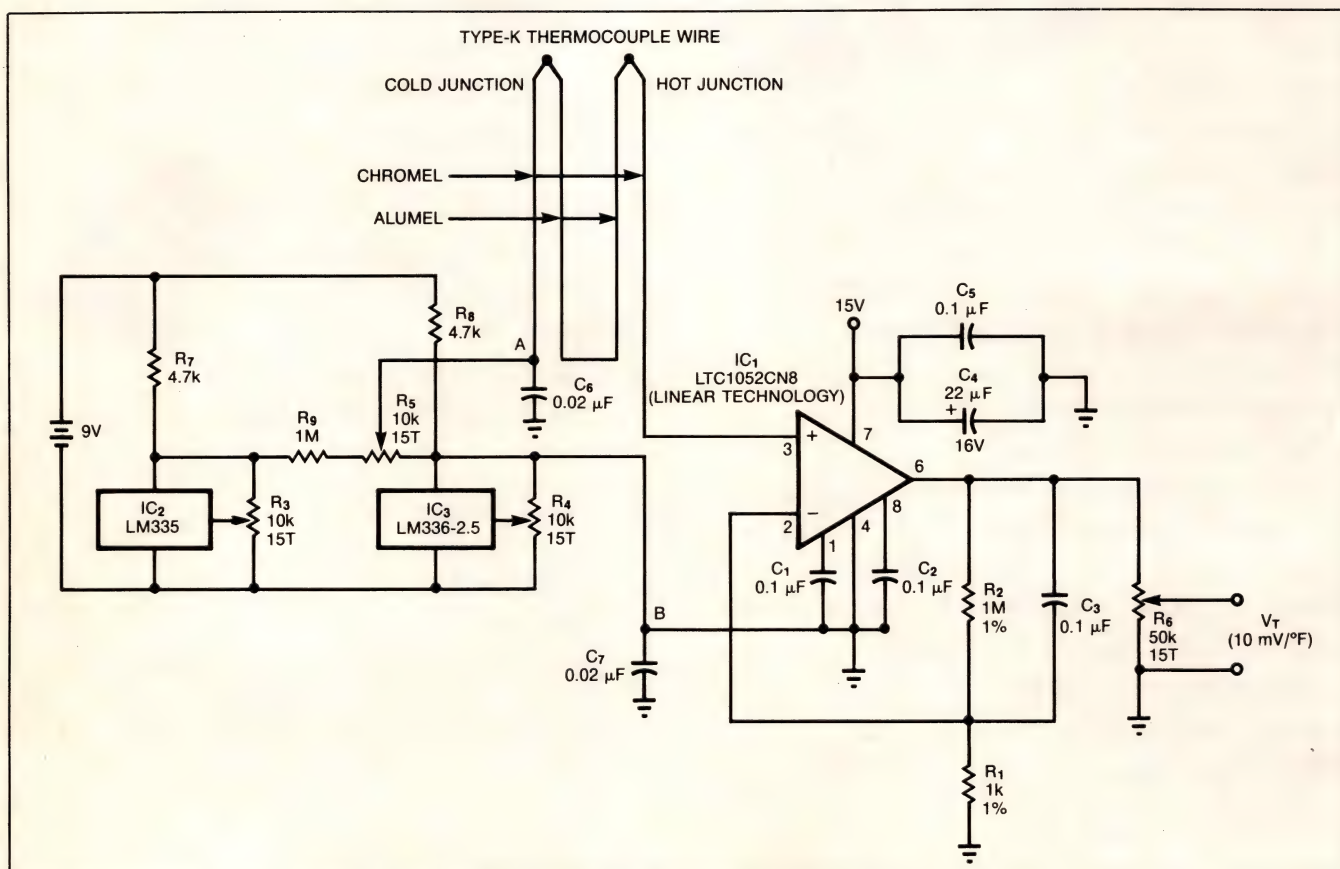
I am writing to express my shock at the Design Idea "Alterable code enhances instructions" by Noor Singh Khalsa (EDN, May 12, 1988, pg 210). I hope that Mr Khalsa takes what follows as criticism of his assumptions and ideas rather than as criticism of him as a person or as a professional engineer. In fact, my criticism is most sharply pointed to the editors of EDN for admitting the design to the magazine's pages.

The very heart of Mr Khalsa's Design Idea is self-modifying code—on a microprocessor that seems to be designed to prevent just that. Do engineers who attempt this practice realize that code and data have been separated by the designers of the 8031 because they are two entirely different kinds of things? Code acts and data is acted upon. To confuse the two by executing data or by modifying code as it runs is to commit an error so grave as to destroy

the very possibility of software design.

What automated design tool, what paper-and-pencil formal design could possibly have been used to generate this kind of code? Do engineers who add that little OR gate in Mr Khalsa's design realize what horrors lie behind the door they've just opened? Are they certain that the next line of code, or the next, or the next will not, under some untested machine state, unintentionally clobber some other line of code?

And to what effect? Will I be a passenger on an aircraft whose avionics software incorporates this design? Are missiles now being prevented from destroying my family by this kind of software? In fact, outside of school, is there any software these days that does not have a serious intent? And if there isn't, should we not simply and firmly state that this design poses an unacceptable risk?



100 V/ μ s GUARANTEED

PMI's OP-44 also guarantees a 15 MHz GBW and full power BW of 1.5 MHz. And no compromises on accuracy. . .

OP-44 HA-2520

V _{OS}	1.0	8	mV max
TCV _{OS}	4	20	μ V/ $^{\circ}$ C typ
A _{VOL}	200	10	V/mV min
I _B	0.2	200	nA max
CMR	86	80	dB min

The OP-44 is available now . . . in 883 too. Get the high-speed facts from our 12-page OP-44 data sheet. Circle the reader service number or call 1-800-843-1515.

Precision Monolithics Inc.
A Bourns Company
Santa Clara, California USA
408-727-9222

FRANCE: (1) 40 03 35 93; GERMANY: (0711) 22 93-0; BENELUX: (070) 87 54 04; SWITZERLAND: (042) 33 33 33;
UNITED KINGDOM: (0276) 692 392; HONG KONG: 0-4992688; JAPAN: (03) 280-1411; ARGENTINA: (46) 5776/0628/0864/2214;
AUSTRALIA: (02) 439-4655; AUSTRIA: (0222) 43 26 39; DENMARK: (02) 98 63 33; FINLAND: (90) 565 38 77; INDIA: 222 999;
ISRAEL: (23) 924 09 25; ITALY: (02) 569 57 46; KOREA: (02) 244-7492; NORWAY: (06) 83 20 00; SINGAPORE: 747-6188;
SPAIN: (91) 405 42 13; SWEDEN: (08) 768 05 60; TAIWAN: (02) 752 2200; YUGOSLAVIA: (041) 42 37 46

CIRCLE NO 48



The precision solution.

Quality Protection for Advanced Technology

Skydyne's Standard Case Lines



Standard Fiberglass Cases—Excellent commercial/shipping containers. Can be modified to meet mil-specs or other specific requirements. 34 sizes to choose from.



Aluminum Sandwich Cases—Skydyne can make any size case, using a unique aluminum sandwich construction, without expensive tooling.



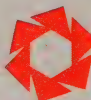
Standard ABS Cases—Excellent commercial/shipping containers. Combines high strength with light weight. 33 sizes available.

Since 1938, Skydyne has met the growing need for durable, lightweight, reusable equipment packaging through its many lines of standard cases. Such cases enable users to easily adapt their display or test equipment to transportable field use. All provide maximum protection against shock, vibration, and hazardous environments encountered during handling and transit. Most are available from stock for immediate shipment.

Custom options and modifications can also be specified for these cases. Contact factory with your requirements.

Call Toll-Free: 800-428-CASE

SKYDYNE
QUALITY PROTECTION FOR ADVANCED TECHNOLOGY



RIVER ROAD • PORT JERVIS, NEW YORK 12771 • 914-856-6655

CIRCLE NO 49

DID YOU KNOW?

Half of all EDN's
articles are staff-written.

EDN

SIGNALS & NOISE

Let me ask another question from a purely selfish standpoint. As a software designer whose job sometimes requires me to interface assembly code to a high-order language, what kind of questions am I likely to get from my customer now that you've revealed self-modifying code as the latest state of the art?

I can't help thinking that our customer, on reading this Design Idea, not realizing the profound sense of outrage it causes for professional software designers, will use it as a justification for making life more difficult for us.

Self-modifying code indeed! EDN should realize that the third digit of this year is an 8 and not a 6.

*Bob Crispen
Decatur, AL*

Design Idea corrections

I'd like to thank you for your acceptance of my Design Idea "Signal-powered switch connects devices" (EDN, April 14, 1988, pg 227) and point out a few errors in the published schematic:

- The signal ground on the DTE side should be labeled pin 7;
- V⁺ of the MBR2045CT is pin 2;
- Pin 8 of the Si7661 should be connected to V⁺.

In response to inquiries I've received, I'd like to mention that the DG509s are bidirectional analog switches, so it's possible to operate the circuit in the opposite direction (that is, to connect one printer to four PCs) if you make appropriate changes to the diode connections. Also, the diode packs are Motorola parts, and the voltage inverter is from Siliconix.

*James Dean
Herzberg Institute of Astrophysics
National Research Council
Canada
Ottawa, Ontario, Canada*

How To Wring Workstation-Level PCB Designs Out Of Your PC.



P-CAD's new Master Designer turns an ordinary PC into a full-fledged PCB workstation.

When you need to wring every drop of performance out of your next PCB design, you need Master Designer™ software.

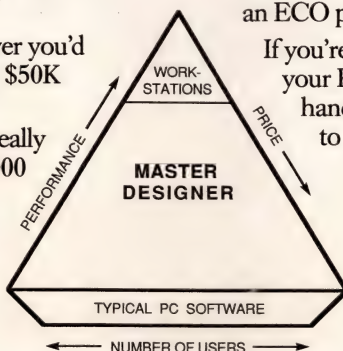
Master Designer provides all the horsepower you'd expect only from workstations priced from \$50K up to as much as \$200K.

With Master Designer you can tackle the really big jobs. Board designs with 500 EICs, 32,000 pins and 2,500 nets are just the beginning. P-CAD's Master Designer routes multiple layers simultaneously cutting the number of vias and unrouted subnets in half.

So, you'll wring out cleaner designs and higher completion rates (up to 100%).

For forward annotation of logic changes and "history independent" back annotation, Master Designer also has an ECO processing option.

If you're interested in wringing every penny out of your PCB design station instead of wringing your hands, ring P-CAD. Let P-CAD show you how to turn a PC into a high-powered workstation.



p-cad
PERSONAL CAD SYSTEMS INC.

1290 Parkmoor Ave., San Jose, CA 95126 USA
Telex: 371-7199 FAX: 408-279-3752

800-628-8748 CA 800-523-5207 U.S.

P-CAD is a registered trademark and Master Designer is a trademark of Personal CAD Systems, Inc.

CIRCLE NO 50

Consistent expansion of the SMD spectrum: eg passive components from Siemens

If you're going to make full use of the benefits of surface mounting, as many passive components as possible have to be available as SMDs.

So if you've hesitated to change to SMDs until now, it's time to think again. Firstly because you don't want to be left behind. Secondly because Siemens is already offering almost all its passive components as SMDs.

Ceramic multilayer chip capacitors have already achieved considerable product maturity. They're notable for their high capacitance/volume ratio and the good solderability of their contacts.

Molded into flame-retarding plastic, MPF chip capacitors can withstand the thermal stress of soldering.

Tantalum chip capacitors have been used for years now in professional

circuits and, increasingly, in consumer electronics.

Also available from Siemens: NTC resistors in IEC 1206 format and PTC resistors in IEC formats 0805, 1210, 1812 and 2220.

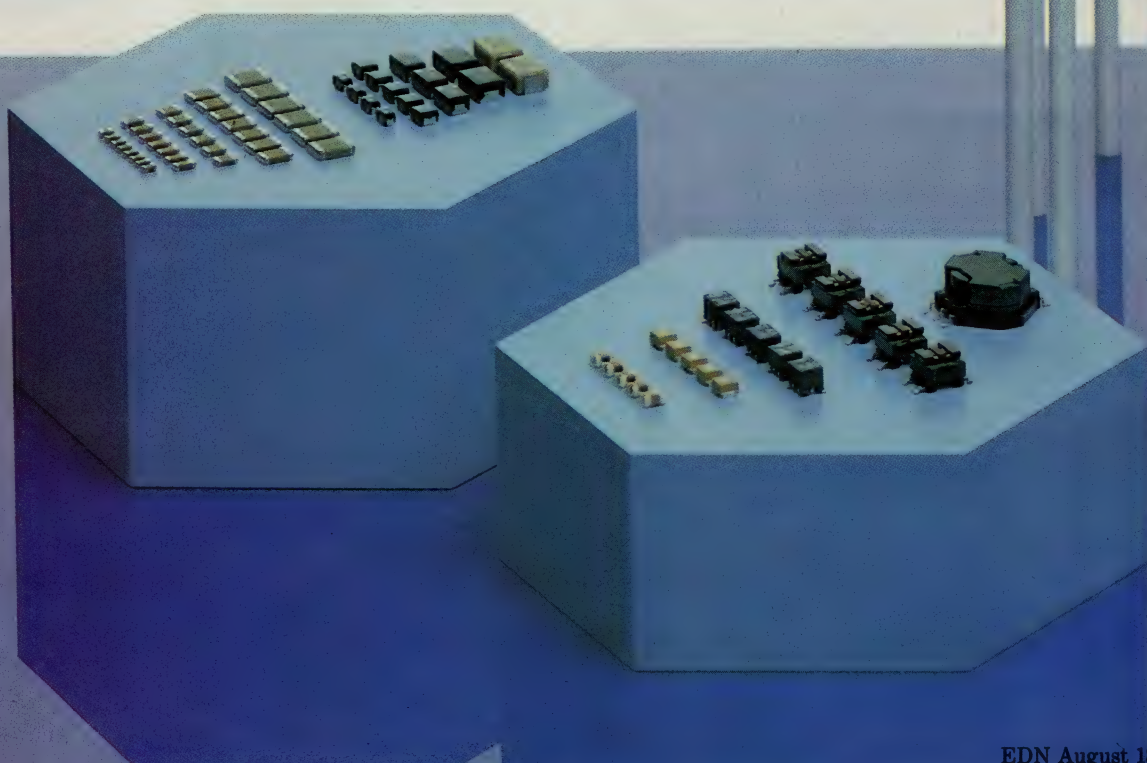
Ferrite sets for transformers, inductances and metal-oxide varistors – encapsulated too for 300 V – round off the allround Siemens SMD range.

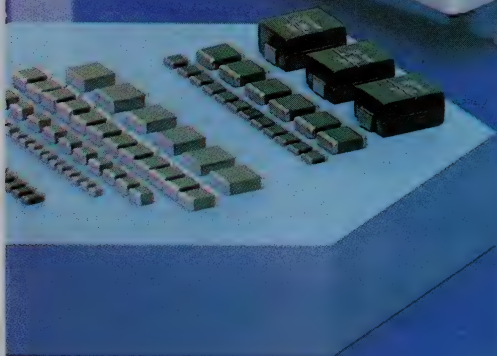
But what's more, Siemens has developed libraries on electronic data media for its SMDs in which all numeric and graphic data are stored ready for CAD. That simplifies and rationalizes the work of PCB layout.

Siemens AG,
Components Group,
Balanstrasse 73,
D-8000 Munich 80

CIRCLE NO 52

12/Z075e





Experience Counts.



EZ-PRO Emulators

Experience quick delivery, easy operation, fast development schedules. EZ-PRO® users reap the benefits of the C language fully integrated with advanced emulation tools, including precedence triggering, Deep Trace™, on-line code revisions, and performance analysis tools.

In addition to IBM® PC-XT/AT, hosts include IBM Personal

System/2™, Macintosh II™, VAX™, MicroVAX™, and Sun Workstation®.

EZ-PRO users also have the advantage of the best post-sales support in the industry.

They know that their emulators are covered by

American Automation's 5-year limited warranty.

Experience counts. Now with over 10 years experience, American Automation has designed more emulators than anyone. Count on EZ-PRO to provide the most cost/effective development support.

Intel: 8031 8086 8032 8086 8035 8088 8039 80186 8344 80188 8048 80286 8049 8050 8051 8085A 8085A2 8096/97	Motorola: 6800 68B00 68HC11A2 68HC11A8 68B02 68000 146805E2 68008 68010 6808 68B08 6809 6809E 68B09 68B09E	Hitachi: 6301R 6301V1 6301X 6301Y 6303R 6305V 63705 6309 6309E 64180R0 64180R1	Rockwell: 6502 6503 6504 6505 6506 6507 6512 6513 6514 6515	RCA: 1802 1805 1806 CDP6805C4 CDP6805C8 CDP6805D2 CDP6805E3	Zilog: Z80A Z80B Z80H Z180 Z8001 Z8002
				Harris: 80C86 80C88	NEC: V20 V40 V30 V50
				National: NSC800	Signetics: 8X300 8X305

...AND MORE

*Assumes EZ-PRO Development Station connected to MSDOS host.

american automation 

2651 Dow Avenue, Tustin, California 92680 (714) 731-1661

FAX: 714/731-6344

IBM is a registered trademark of International Business Machines, VAX and MicroVAX are registered trademarks of Digital Equipment Corporation, Macintosh is a registered trademark of Apple Computer, Inc., Sun Workstation is a registered trademark of Sun Microsystems, Inc.

**Because you're
thinking fast...**

you need responsive suppliers as well as fast parts. Comlinear is tuned in. With high quality, high-speed products. Assistance from R&D-level applications engineers to help develop your ideas quicker. Sales and distribution that get you what you need fast. Quality product documentation with guaranteed specs so you don't waste time. In your business, time is everything. Count on us for the speed you need.

What could you do with a 12ns settling op amp that has instantaneous output clamping and 1ns overload recovery? Plenty.

With clamping performance like this—plus an 80MHz bandwidth and 12ns settling time to 0.05%—the new CLC501 Clamping Op Amp is the residue amplifier you've been searching for in subranging A/D applications.

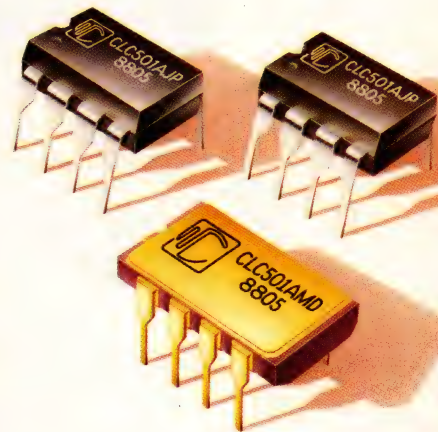
Its 1ns overload recovery makes it the op amp you've wanted for resolving small signals ordinarily lost following large, saturating signals in radar, optical communications, and line testing applications.

User-settable output clamping means it's the only high-speed op amp that gives you a simple yet flexible solution for protecting downstream circuits.

And its 50MHz clamping input bandwidth opens up new design possibilities. Such as modulating a square wave to produce pulse amplitude modulation. When there's a new concept in op amps, there's no telling where the applications end.

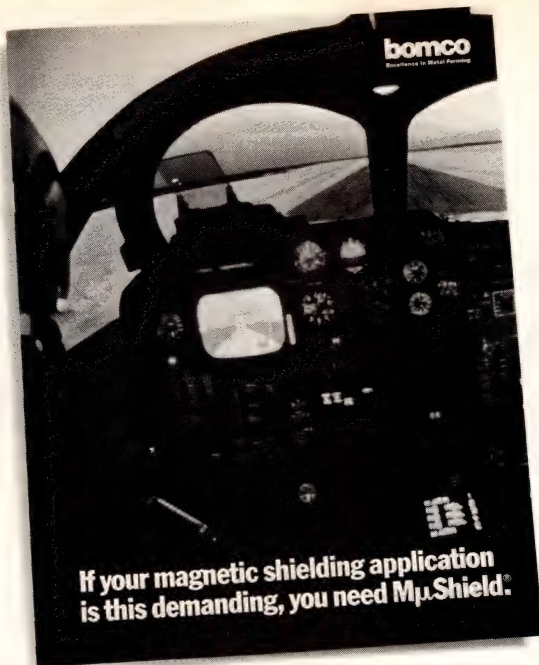
Call today for details on the op amp designed to tickle your imagination.

CIRCLE NO 53



**Comlinear
Corporation**
Solutions with speed

4800 Wheaton Drive
Fort Collins, Colorado 80525
(303) 226-0500



Free MμShield Magnetic Shielding Catalog

For customized shielding, MμShield materials from stock, and consultation services, contact MμShield Products Division, Bomco, Inc., PO Box W, 103 Madison St., Malden, MA 02148-6890. Phone 508/321-4410. Fax 508/324-9563.

bomco
Excellence In Metal Forming

CIRCLE NO 54

INTEL EMBEDDED CONTROLLERS GIVE INDUSTRY A HAND.

Now you can give a robot arm the precision that comes with 4.3 megawhetstones performance on a single chip. With a member of Intel's 80960 family. Just call 800-548-4725 (Lit. Dept. 437).



intel

CIRCLE NO 55

CALENDAR

Midcon, Dallas, TX. Electronic Conventions Management, 8110 Airport Blvd, Los Angeles, CA 90045. (800) 421-6816; in CA, (213) 772-2965. August 30 to September 1.

Surface Mount '88, Marlborough, MA. MG Expositions Group, 1050 Commonwealth Ave, Boston, MA 02215. (800) 223-7126; in MA, (617) 232-3976. August 30 to September 1.

Modern Electronic Packaging (seminar), Santa Clara, CA. Technology Seminars, Box 487, Lutherville, MD 21093. (301) 269-4102. September 7 to 9.

International Test Conference, Washington, DC. Doris Thomas, ITC, Box 264, Mount Freedom, NJ 07970. (201) 267-7120. September 12 to 14.

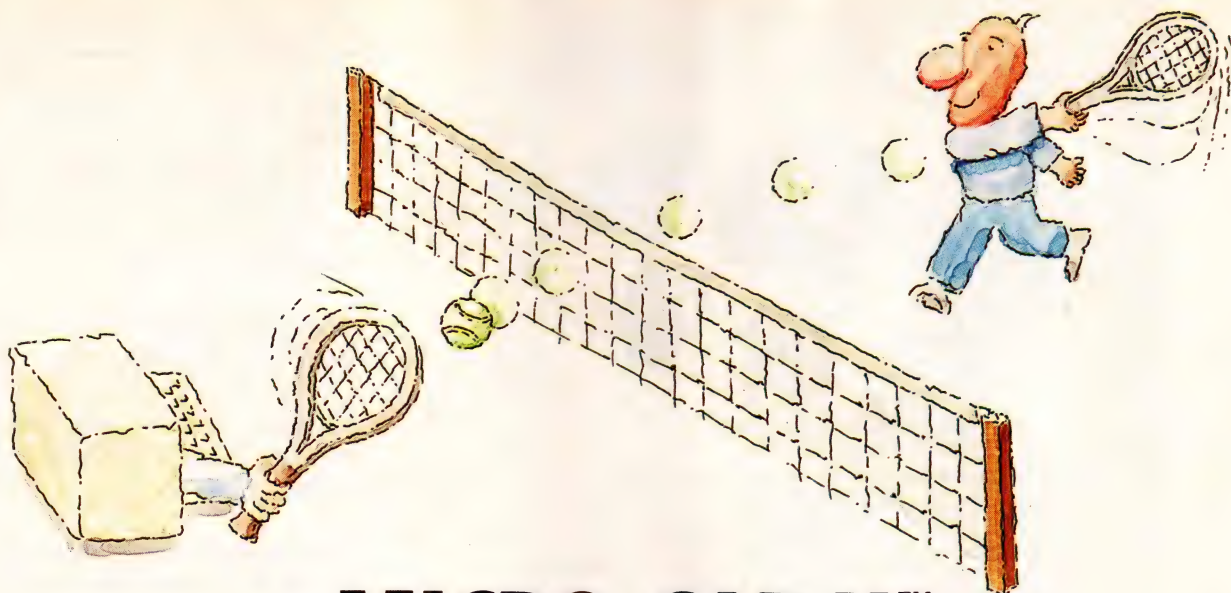
Worst-Case Circuit Analysis (seminar), Boston, MA. Design and Evaluation, 1000 White Horse Rd, Suite 304, Voorhees, NJ 08043. (609) 770-0800. September 12 to 14.

C Programming Workshop (short course), Seattle, WA. SSC, Box 55549, Seattle, WA 98155. (206) 527-3385. September 12 to 15.

12th International Fiber Optic Communications and Local Area Networks Exposition, Atlanta, GA. Information Gatekeepers, 214 Harvard Ave, Boston, MA 02134. (800) 323-1088; in MA, (617) 232-3111. September 13 to 16.

Unix Hands-on Workshop (short course), Montreal, Canada. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 13 to 16.

Troubleshooting Microprocessor-Based Equipment and Digital Devices, Atlanta, GA. Micro Systems Institute, 73 Institute Rd, Garnett, KS 66032. (800) 247-5239; in KS, (913) 898-4695. September 19 to 22.

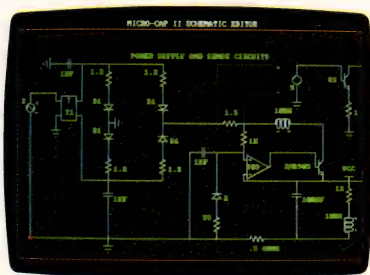


MICRO-CAP II.™

The CAE tool with fully interactive analog simulation for your PC.

Spectrum Software's MICRO-CAP II® is fast, powerful, and feature rich. This fully interactive, advanced electronic circuit analysis program helps engineers speed through analog problems right at their own PCs.

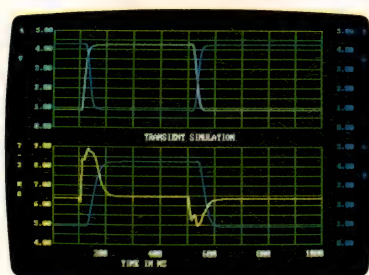
MICRO-CAP II, which is based on our original MICRO-CAP software, is a field-proven, second-generation program. But it's dramatically improved.



Schematic Editor

MICRO-CAP II has faster analysis routines. Better resolution and color. Larger libraries. All add up to a powerful, cost-effective CAE tool for your PC.

The program has a sophisticated integrated schematic editor with a pan capability. Just sketch and analyze. You can step



Transient Analysis

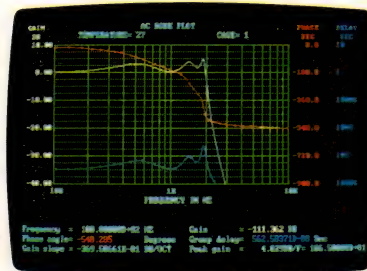
component values, and run worst-case scenarios—all interactively. And a 500-type* library of standard parts is at your fingertips for added flexibility.

MICRO-CAP II is available for IBM® PCs and Macintosh.™ The IBM version is CGA, EGA, and Hercules® compatible and costs only \$895 complete. An evaluation version is available for \$100. Call or write today for our free brochure and demo disk. We'd like to tell you more about analog solutions in the fast lane.

- Integrated schematic editor
- Fast analysis routines
- High-resolution graphic output
- Standard parts library of 500* types

*IBM versions only.

- Transient, AC, DC, and FFT routines
- Op-amp and switch models
- Spec-sheet-to-model converter*
- Printer and plotter* hard copy



AC Analysis

spectrum

1021 S. Wolfe Road, Dept. E
Sunnyvale, CA 94087
(408) 738-4387

MICRO-CAP II is a registered trademark of Spectrum Software.

Macintosh is a trademark of McIntosh Laboratory, Inc. and is being used with express permission of its owner.

Hercules is a registered trademark of Hercules Computer Technology

IBM is a registered trademark of International Business Machines, Inc.

DC-DC CONVERTERS

To 25 Watts — From ERG —
Your DC PowerHouse!



- **ERG DC-DC CONVERTERS.**

Inputs from 5 to 48 VDC. Outputs from 5 VDC to 1500 VDC. Single, dual, center-tap (+/-) outputs. Regulated and unregulated. **Ask about our New Step-Down converters for battery-powered logic and other applications!**

- **SMART FORCE™ INVERTERS FOR EL LAMPS!**

Smart Force DC-AC Inverters extend the useful life of Electroluminescent lamps. Power EL to backlight LCDs and membrane switches, and more! **Ask about our New miniaturized P Package Inverters!**

Call today for complete product information and pricing:



Endicott Research Group, Inc.

2601 Wayne Street P.O. Box 269 Endicott, NY 13760
® 607-754-9187 TWX 510-252-0155

FAX: 607-754-9255

©1986 ERG, Inc.



CIRCLE NO 175

INTEL FLASH MEMORIES KNOW YOUR TYPE.

Now, even when the power is off, your laser printer can remember type fonts. Cost-effectively. Only with an Intel Flash memory.
Just call 800-548-4725 (Lit. Dept. 463).



intel®

©1988 Intel Corporation

CIRCLE NO 82

CALENDAR

Unix Hands-on Workshop (short course), Washington, DC. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 20 to 23.

34th IEEE Holm Conference on Electrical Contacts, San Francisco, CA. IEEE Holm Conference Registrar, 345 E 47th St, New York, NY 10017. (212) 705-7405. September 26 to 29.

Troubleshooting Microprocessor-Based Equipment and Digital Devices, Chicago, IL. Micro Systems Institute, 73 Institute Rd, Garnett, KS 66032. (800) 247-5239; in KS, (913) 898-4695. September 27 to 30.

Unix Hands-on Workshop (short course), San Diego, CA. Integrated Computer Systems, Box 3614, Culver City, CA 90231. (800) 421-8166; in CA, (213) 417-8888. September 27 to 30.

Connector and Interconnection Technology Symposium, Dallas, TX. Electronic Connector Study Group, 104 Wilnot Rd, Suite 201, Deerfield, IL 60015. (312) 940-8800. October 3 to 5.

IEEE International Conference on Computer Design: VLSI in Computers and Processors, Port Chester, NY. Gail Clanton, IEEE, 1730 Massachusetts Ave NW, Washington, DC 20036. (202) 371-1013. October 3 to 5.

Autotestcon, Minneapolis, MN. Steve Palmer, Unisys, 3333 Pilot Knob Rd, Eagan, MN 55121. (612) 456-2349. October 4 to 6.

Buscon/88 East, New York, NY. Conference Management Corp, 200 Connecticut Ave, Norwalk, CT 06856. (203) 852-0500. October 4 to 6.



**When it comes to competition
in the compatibles marketplace,
are you going to grab
the bull by the tail?**



Or by the

There's only one thing tougher than getting ahead of the industry standard these days. *Staying ahead.*

To stay ahead in the compatibles market you need a technology partner that's a proven leader: Chips and Technologies.

Our CHIPSets™ for PS/2™ and AT-compatibles are based on a powerful asynchronous architecture. Offering you the ultimate in future product line flexibility and design investment protection. While focusing on your advanced-product marketing opportunities.

The only full range of super-compatibles.

Wherever you drive your IBM-compatible lines, the CHIPSet family will support you. We're ready for PS/2 Model 70-compatibles today. With the only small footprint, high performance solution.

Configuring a Model 50- or Model 80-compatible desktop or tower? We're ready now. In fact, throughout the entire PS/2 family, you can choose *any* microprocessor architecture—286, 386™—even the new 386SX. Running at *any* speed to 25 MHz and beyond. With whatever DRAM solution prevailing cost and availability dictate.

horns?



For the ultimate in AT-compatible designs, our 286/NEAT™ and 386/AT CHIPSets dominate.

They're the result of four years experience building integrated CHIPSets now used in over 5 million microcomputers. While other chips hit the wall at 12 MHz, only CHIPSets support a full range of processors and clock speeds.

Why take a chance with partial solutions which might box you in? CHIPSets solve your system-level design problems today. Providing tightly-coupled subsystem solutions for VGA graphics, mass storage and communications, too. And our unique Design Services Organization offers assistance ranging from technical consultation to the design of entire systems.

Only CHIPSets offer the high-performance compatible options you need today and the migration path you must have to plan for tomorrow. Call 800-323-4477 for information.



chip sets or CHIPSets.™ The difference is the difference.

Chips and Technologies, Inc. 3050 Zanker Road, Department MC-2, San Jose, CA 95134. PS/2 is a trademark of IBM Corporation. 386 is a trademark of Intel Corporation. CHIPSet, NEAT and CHIPS/280 are trademarks of Chips and Technologies, Inc. © 1988, Chips and Technologies, Inc.



\$4990

DN3000 with 15" 1024 x 800 monochrome display



\$5990

DN3000 with 19" 1280 x 1024 monochrome display



\$8900

DN3000 with 15" 1024 x 800 color display

If you think we don't have UNIX workstation for unc



\$7990

*DN3500 MC68030-based 4-MIPS workstation
with 15" 1024 x 800 monochrome display*



\$8990

*DN3500 MC68030-based 4-MIPS workstation
with 19" 1280 x 1024 monochrome display*



\$9990

*DN3500 MC68030-based 4-MIPS workstation
with 15" 1024 x 800 color display*

Open Software
FOUNDATION

Apollo is proud to be a founding sponsor of the Open Software Foundation.

At Apollo, we believe that the real test of a computer company is not only how often it introduces new technology, but also how quickly it makes that technology available at a truly affordable price.

As testimony to this, we offer not simply one workstation under \$10,000, but two entire families of workstations, one of which starts at under \$5,000.

Consider the Series 3000.[™] A Personal Workstation[™] powered like a Porsche[®] but priced like a PC. \$4,990, to be exact. And the new Series 3500.[™] An MC68030 machine that brings high performance to a new low. Making it possible for the first time to obtain a

a single high-performance er \$10,000, you're right.

4-MIPS monochrome system for less than \$8,000, and a 4-MIPS color system for less than \$10,000.

Prices that even include 4MB of memory, a floating-point coprocessor, an IBM PC AT[®]-compatible bus, and a choice of Ethernet[®] or Apollo Token Ring networks.

In addition, like all Apollo workstations, these provide support for industry standards such as UNIX[®] (System V.3 and Berkeley 4.3), PHIGS, X Window System[™] and a host of others, as well as network computing and PC compatibility.

The Apollo Series 3000 and Series 3500. Technology as high as the price is low.

apollo

For more information, call 1-800-323-1846, and in Massachusetts (1-800-847-1011) or write Apollo, 330 Billerica Road, Chelmsford, MA 01824.

Apollo is a registered trademark and Series 3000, Series 3500, and Personal Workstation are trademarks of Apollo Computer Inc. UNIX is a registered trademark of AT&T. Ethernet is a registered trademark of Xerox Corporation. X Window System is a trademark of MIT. AT is a registered trademark of International Business Machines Corporation. Porsche is a registered trademark of Porsche North America, Inc.

XICOR RAISES MILITARY DESIGNS TO A HIGHER LEVEL.

E²PROM

Our full military E²PROM line-up gives you one-stop shopping convenience.

Now you can promote your memory-intensive military designs to a higher level of functionality. With Xicor's complete line of military E²PROMs, NOVRAMs and E² potentiometers.

They raise system performance and power economies to a new level. And unlike most memories, Xicor E² devices can be remotely reprogrammed in the field, via telephone link. In the case of our E² potentiometers, they can automatically tune themselves while in service—kind of like an "electronic screwdriver." Plus our high density E²PROM memories are loaded with features like Page Mode, DATA Polling, Toggle Bit and Software Data Protection.

Volume-manufactured in JEDEC-approved pin-outs, Xicor E² devices come in all the popular packaging configurations, including surface mount. And they're backed by Xicor's on-site technical design support. For more details on JAN, DESC Drawing and 883C products, call (408) 432-8888 today, or write: Xicor, Inc., 851 Buckeye Court, Milpitas, CA 95035.

E ² PROM Part No.	Organ.	Page Size (# Bytes)	Access Time (ns)	NOVRAM Part No.	Organ.
X2804AM	512 x 8	N/A	300, 350, 450	X2210M	64 x 4
X2816AM	2048 x 8	N/A	300, 350, 450	X2212M	256 x 4
X2816BM	2048 x 8	16	250, 300	X2004M	512 x 8
X2864AM	8192 x 8	16	250, 300, 350, 450	Serial I/O Part No.	Organ.
X2864BM	8192 x 8	32	120, 150, 180	NOVRAM X2444M	16 x 16
X2864HM	8192 x 8	32	90	E ² PROM X2404M	512 x 8
X28256M	32768 x 8	64	250, 300, 350	E ² PROM X24C16M	2048 x 8
X28C256M	32768 x 8	64	250, 300, 350	E²POT™ Part No.	Max. Resis.
XM28C010M	131072 x 8	64	250, 300	X9103M	10K Ω
				X9503M	50K Ω
				X9104M	100K Ω

E²POT™ digitally controlled potentiometer is a trademark of Xicor, Inc.

Xicor®

MAKES IT MEMORABLE

EDN August 18, 1988

EDITORIAL

That's the way the trade problems crumble



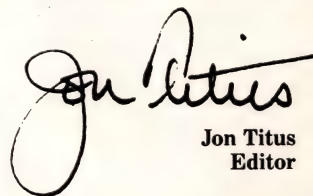
The recent shortage of dynamic-RAM chips has set off a new round of discussions about working with our Asian trading partners. It turns out that there may be a way to help solve some of the semiconductor and trade problems. But before you hear my proposal, you'll need a little background information.

Earlier this year, Federal Express began a new service: It started shipping small packages to Japan at prices lower than the normal shipping costs of Japanese carriers. Because the Japanese have no similar small-package courier service, they decided to stop or slow Federal Express until one of their domestic carriers could offer a competitive service. Instead of levying enough duties and restrictions to shut down Federal Express's new service outright, the Japanese demanded shipping documents for each Federal Express package. The extra paperwork and complex customs processing are making Federal Express shipments uncompetitive with the Japanese shippers, according to *Business Week* (May 30, 1988, pg 116).

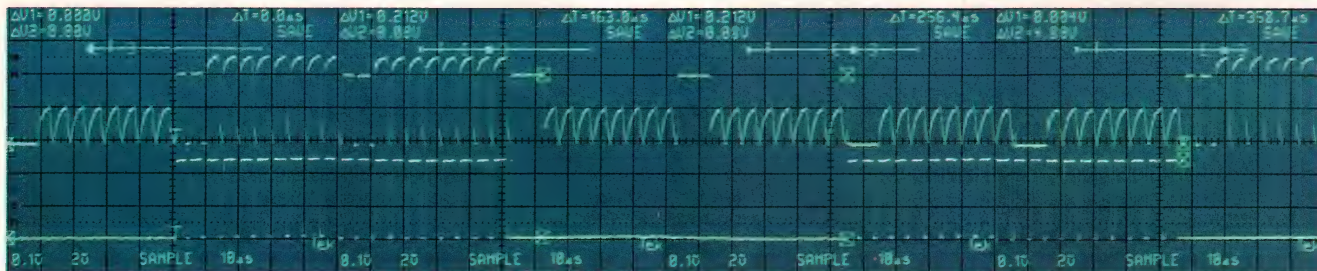
At about the same time, the Japanese taught the Girl Scouts of America a lesson about international trade. US Navy personnel stationed in Japan ordered Girl Scout cookies at \$2 per box. Unfortunately for the sailors, when the cookies arrived in Japan, the unfathomable customs inspectors placed a \$5 duty on each box. After all, cookies are agricultural products which threaten Japanese suppliers' markets. In the end, US Congressional intercession carried the day, and the sailors got their cookies.

Now we're facing a semiconductor crisis that threatens US computer manufacturers—almost all of whom rely on now-scarce DRAM chips from Asia. According to industry watcher Warren Andrews, there may be a conspiracy among foreign DRAM vendors to keep supplies scarce and thus keep prices high. Andrews thinks that the DRAM shortages are part of a concerted plan by Japanese suppliers who ultimately want to control the computer-board and -systems markets, too.

Well, like it or not, the time has come to retaliate against the Japanese by giving them a taste of their own medicine. Just as we depend on DRAMs, Japanese manufacturers depend on many types of US-made semiconductors. But instead of planning a price-and-supply conspiracy, we'll take another approach. Here's the plan: From now on, whenever US companies ship semiconductor products to Japan, they should send them by Federal Express. Let's set a limit of 12 parts per package, though. Also, to show our good will, we'll throw in a box of Girl Scout cookies with each order—I recommend the sticky chocolate-covered Samoas. Perhaps someone in Japan will get the message.


Jon Titus
Editor

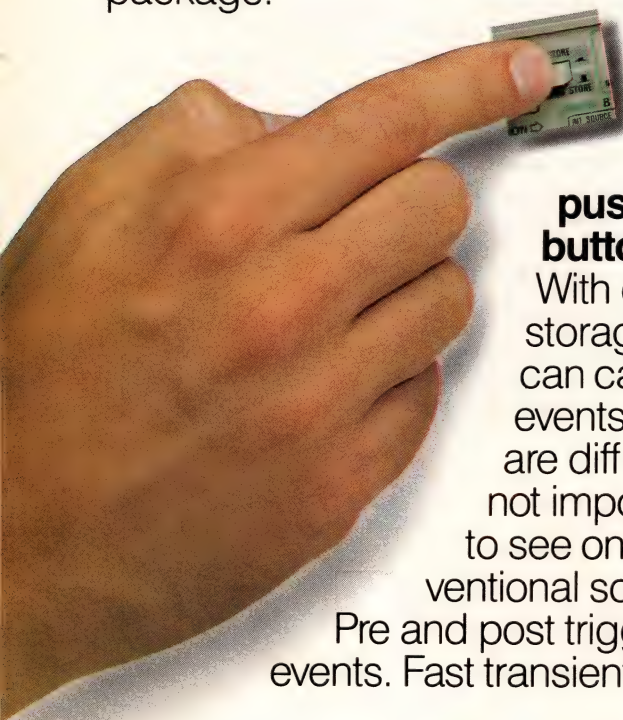
Digital scopes with a



Give up real-time capability for storage? Not with Tek!

That's because analog capability is integral to low-cost Tek digital storage oscilloscopes. So you need only one instrument to make all your measurements efficiently. With no trade-offs.

It's another Tek advantage: analog and digital in one familiar, affordable package.



Select either mode at the push of a button.

With digital storage you can capture events which are difficult if not impossible to see on conventional scopes. Pre and post trigger events. Fast transients.

Single-shot events.
Elusive glitches.
Low-speed phenomena.

Four screen photos spliced end to end illustrate the benefit of full four-screen capture using the 2230's 4K record length.

Any waveform can be viewed for as long as you like. Or stored in 4K of memory for later analysis or comparison to other waveforms. And if there's a question about a digital measurement, just push a button for real-time display analysis.



real-time advantage.

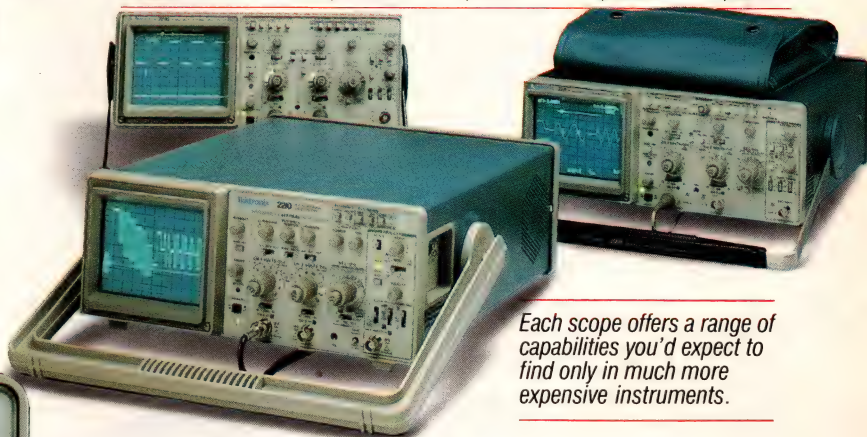
The affordable portables.

These are the world's best-selling digital storage oscilloscopes. And with the new 50 MHz Tek 2210 joining the family, there's now an even better selection—in bandwidth, performance and price.

Select for advanced features such as 100 ns glitch capture at any sweep speed, CRT readout, measurement cursors, multiple acquisition modes and hardcopy output, plus optional GPIB or RS-232C interfaces and software.

These scopes are perfect for first-time digital users. And seasoned operators will appreciate even more their versatility, convenience and value. All backed

Features	2230	2221	2220	2210
Bandwidth	100 MHz	60 MHz	60 MHz	50 MHz
Max. Sampling Speed	20 MS/s	20 MS/s	20 MS/s	20 MS/s
Vertical Resolution	8-12 bits	8-10 bits	8 bits	8 bits
Record Length	4K	4K	4K	4K
Glitch Capture	100 ns	100 ns	100 ns	No
CRT Readout/Cursors	Yes	Yes	No	No
GPIB/RS-232-C Options	Yes	Yes	Yes	No
Warranty	3-years on labor and parts including CRT			
Price	\$4995	\$3995	\$2995	\$2395



Each scope offers a range of capabilities you'd expect to find only in much more expensive instruments.

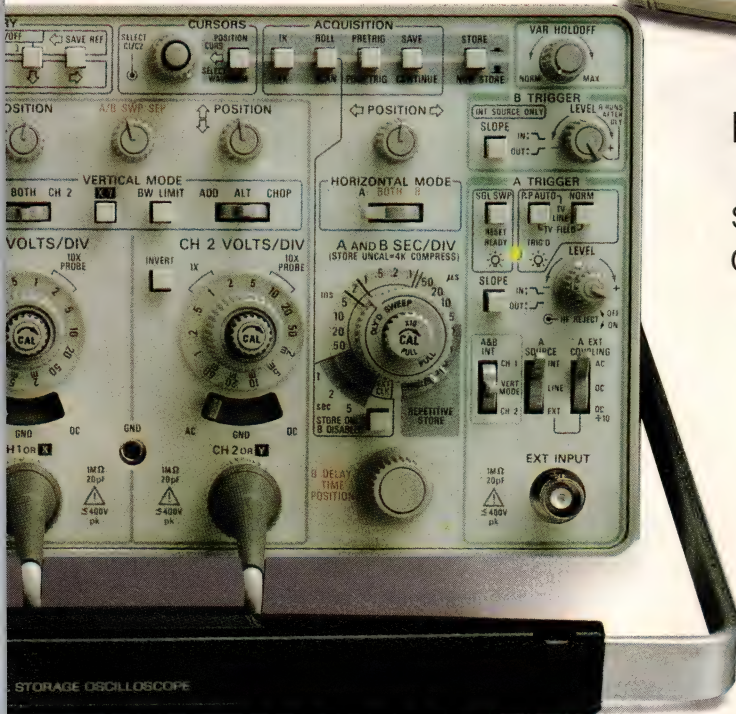
by Tek quality and a 3-year warranty.

Discover the potential. Let Tek show you what you're missing... without making you give up analog to see it. That's the real-time advantage of Tek digital storage.

For easy ordering or more information call Tek Direct:

1-800-426-2200

VISA, MasterCard



Tektronix®
COMMITTED TO EXCELLENCE

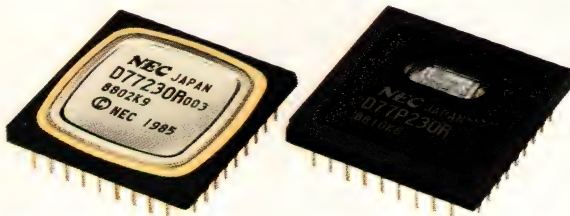
The 32-bit floating point processor

Expert support complements leading-edge technology.

NEC is the front-runner in DSP technology. The proof? Our μ PD77230 32-bit Floating Point Processor with 13.4-MFLOPS performance is now in mass production.

And we back it with enhanced support services. To speed your programming, we offer a complete set of development tools and an EPROM version. DSP applications specialists are waiting to give you expert advice and the latest application notes at our worldwide network of support centers.

For a faster, easier design-in, call NEC. We'll give you leading-edge DSP technology and support to match.



For fast answers, call us at:

USA Tel: 1-800-632-3531. TWX: 910-379-6985. Sweden Tel: 08-732-8200. Telex: 13839.
W. Germany Tel: 0211-650302. Telex: 8589960. France Tel: 1-3946-9617. Telex: 699499.
The Netherlands Tel: 040-445-845. Telex: 51923. Italy Tel: 02-6709108. Telex: 315355.

from the DSP pioneer.



*Junko Sunaga
Application Engineer
Semiconductor Application
Engineering Division.*

UK Tel: 0908-691133. Telex: 826791. Singapore Tel: 4819881. Telex: 39726.
Hong Kong Tel: 3-755-9008. Telex: 54561. Australia Tel: 03-267-6355. Telex: 38343.
Taiwan Tel: 02-522-4192. Telex: 22372.

NEC

NOTHING FO SWERVES OR TO YOUR SPE BEND/FLEX.®

More flexible
than rigid glass epoxy
boards. More rigid than
polyimide film.
BEND/flex bendable
circuit board material*
from Rogers. The best of
two technologies with a
remarkable new twist:
reduced production
costs of up to 30%.

BEND/flex vs. rigid glass epoxy boards.

No more difficult design problems, labor-intensive wire harnesses or costly board-to-board interconnects. With BEND/flex, you design on a single board, bend or curve to meet your space requirements—even unfold to inspect or repair components. And BEND/flex is rugged enough to handle standard processing techniques, including wave-soldering and pick-and-place automation assembly.

RMS, BENDS, CURVES CS LIKE

BEND/flex vs. polyimide film flex circuits.

No more high-priced circuits, added board-stiffeners or costly processing techniques. With BEND/flex, you can save material and manufacturing costs without sacrificing design flexibility or performance. In fact, in certain applications, BEND/flex has been shown to increase overall product performance.

BEND/flex. Save space, time and manufacturing costs. With the only circuit board material bendable enough, strong enough, to meet the demands of small-space design. And, increase your bottom line.

For all the ways BEND/flex can improve your design options, call a

BEND/flex product specialist at (203) 774-9605. Or send in the coupon.

Please send me BEND/flex technical information and samples. EDN081888

Name

Title

Company

Address

City

State Zip

Tel.

BEND/flex meets ANSI/IPC-FC-24/1B/6.

U.L. 94V0 flame class rating.

BEND/flex is a registered trademark of Rogers Corporation.

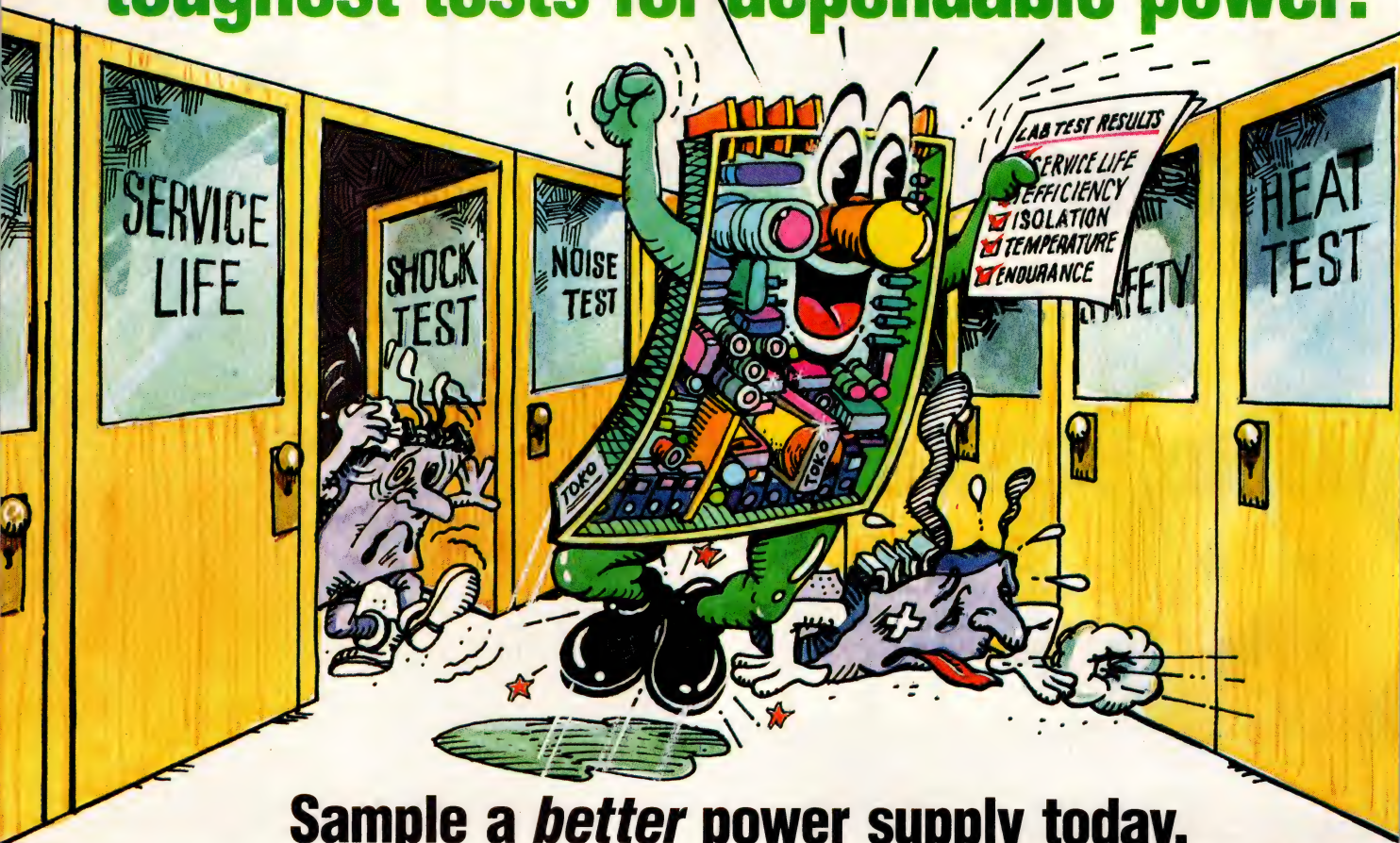


ROGERS

Rogers Corporation
Poron/Composites Division
One Technology Drive
Rogers, CT 06263

*Available in 0.0085", 0.015", 0.020" and 0.030" thicknesses.

Toko switchers will pass your toughest tests for dependable power!



Sample a *better* power supply today.

Toko's switching power supplies do more than look good on paper. They stand up to punishment that makes others fail. Here are the report results.

Long service life.

With MTBF of up to well over 200,000 hours, 105°C electrolytic capacitors, 8-hour burn-in, and 20% derating of all components, it's no wonder customers rarely need to use our two-year performance guarantee.

Efficiency that pays long-term dividends.

Toko maintains a low parts count so there's less to go wrong. Our unique filtering circuitry and state-of-the-art thin copper film transformer design helps achieve greater efficiency and lower switching noise, and eliminates the chances of an open winding or a short.

Maximum protection, inside and out.

Solder masks provide superior board insulation, while overcurrent, overvoltage and in-rush current protection safeguard your equipment and secondary side components.

Cool Power.

Toko's entire 8 to 150 watt power range is designed with convection cooling, assuring no heat dissipation problems.

SERIES	VAC INPUT VOLTAGE	RATED POWER	# OUTPUTS	SMALLEST DIMENSIONS H L W
MW	85-132/ 170-264	100W	4	1.6" 7.8" 4.4"
		50W	3	1.0" 6.1" 3.7"
	85-264	15/30W	3	1.0" 4.3" 2.4"
PT	85-132	15/30W	3	3.2" 5.0" 1.5"
	90-132	50/75/100W	3	4.4" 7.8" 2.0"
ET	85-132	10/15W	3	2.6" 4.5" 1.3"
EM	170-264	10/15W	3	2.6" 4.5" 1.3"
PS	85-132	10/15/30 50/100W	1	3.8" 3.5" 1.0"
PE	85-132	30/50/100W	1	3.8" 6.3" 1.4"
AS	90-132	75W	1	1.6" 8.0" 4.9"
AR	85-132	150W	1	2.0" 10.3" 6.8"
MK	85-132	150W	1	3.8" 6.7" 2.4"

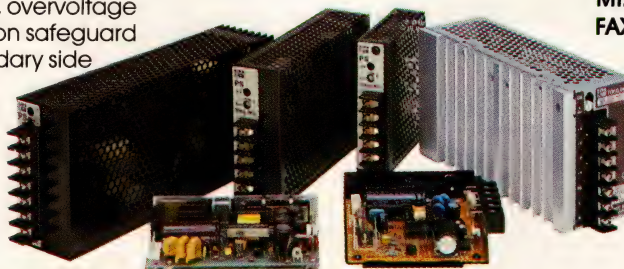
Tougher endurance test results.

Toko's vibration resistance and shock tests prove that the horizontal mounting of our components is superior in mechanical fault resistance to the vertical mounting used by others.

Toko's line of compact switchers

are available in over 300 off-the-shelf supplies, ready to pass your most demanding tests. Toko has no up-charges for modifications that others consider to be "custom." (Modifications to output voltage, input/output connections, regulated or unregulated secondary outputs are delivered at standard lead times—no charge!)

Ask about our Free Evaluation Sample Program. For a free power supply guide and to discuss your own special requirements, write or call Toko America, 1250 Feehanville Drive, Mt. Prospect, IL 60056, (312) 297-0070 FAX (GIII): (312) 699-7864



TOKO
TOKO AMERICA, INC.

*Your strategic partner...
for all the right reasons.*

TECHNOLOGY UPDATE

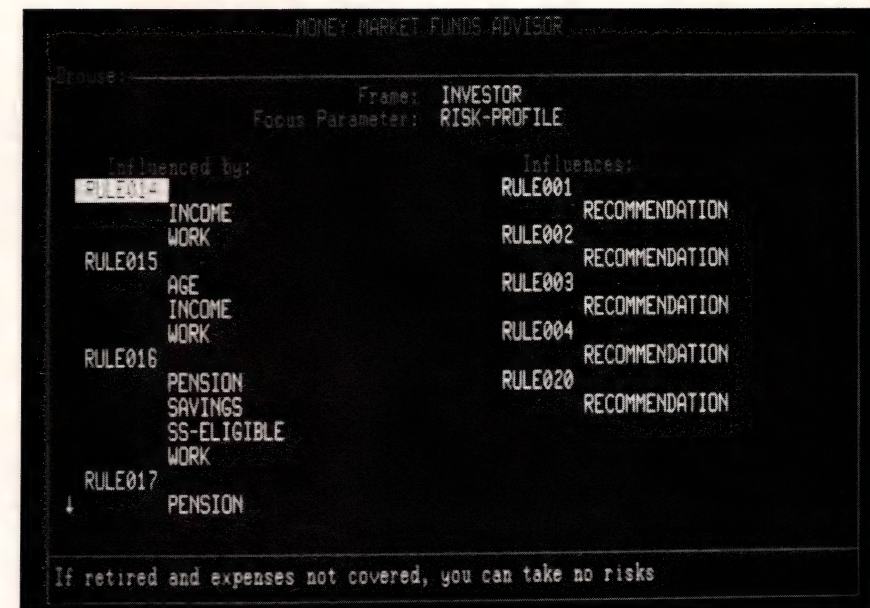
PC-based development products move AI out of the classroom, into the workplace

Chris Terry, *Associate Editor*

Artificial intelligence (AI) was the dreamchild of the 50s—or perhaps it was Aladdin's lamp, which would release a genie of unlimited power and wisdom. In the 70s, it was an expensive lab toy, with which people attempted to make huge computers emulate what they called "natural intelligence," or the structure and method of performing tasks. The scientific results and social implications of AI were—and still are—hotly disputed, and many of the original goals have proved unrealizable, misdirected, or just not commercially useful at present. Nevertheless, the spinoffs from AI research include many new techniques for problem solving and much valuable knowledge about how to define tasks accurately.

You no longer need a supercomputer to run AI-related programs; many such programs will run on modest machines such as the IBM PC/AT and compatibles. Most of the AI products available for PCs are "expert-system shells," tools that let you interrogate a human expert in a given field and build not only his factual knowledge, but also his approach to problem solving, into an "expert system." GoldWorks from Gold Hill Computers is an example. Such a system can help a nonexpert in a certain field to perform a complex task that requires insight into the relative importance of the phenomena observed under varying conditions.

Another AI-based technique that may have important implications for both the hardware and the software of massively parallel systems is the neural network, which is a network of small processors (or their soft-



Most expert systems will show you a list of the existing rules, as well as the dependencies between them. The Texas Instruments Personal Consultant Plus 3.0, for example, lets you create complex expert-system applications for 80286/80386, DOS-based personal computers.

ware equivalent) that purports to model the interconnections and behavior of the neurons in the human brain. A large neural network requires extensive computing power and resources, but at least two simulators that run on PCs and compatibles—Netzwerkz from DAIR Computer Systems and Awareness from Neural Systems—can demonstrate the more-obvious properties of neural networks and allow you to familiarize yourself with these properties.

New programming techniques have also emerged from AI studies, as have some new programming languages (and new dialects of established languages) that facilitate them. These techniques can enhance both the performance and the user interface of more traditional applications, such as database managers.

Before examining the details of

expert-system shells, neural networks, and language tools, it may be helpful to consider briefly what AI is and how AI programs differ from traditional programs. "Artificial intelligence" is the general term for an academic field of research that studies the parameters of task performance by designing a system to perform a task, and then seeing how well the system succeeds.

If you wonder how that procedure differs from the design of any other system, consider Elaine Rich's definition: "Artificial intelligence is the study of how to make computers do things at which, at present, people are better" (Ref 1). If you're still confused, ponder the further simplification of the cynic who said: "If we know how we do it, it ain't AI."

One of the dilemmas that AI-systems designers face is that human language is governed by all kinds of implicit assumptions. For example,

The complex world of microprocessor development just got simpler.

As the challenges of developing and debugging embedded microprocessor designs becomes more and more complex, you need the best development tools possible.

And nobody offers you higher reliability, better performance or a quicker way to develop and debug your 8, 16 or 32-bit systems than Applied Microsystems.

Our emulators, for example, can be controlled from the host computer you work with (VAX, Sun, Apollo, IBM PC or compatible). Your target system will run exactly as if its microprocessor were in place. And you'll get a clear picture of your design and how it interfaces with interrupts, clocks and the flow of software.

Our emulators are designed to work with easy-to-use VALIDATE software to give you powerful source level or symbolic debugging capabilities. You also get our powerful Event Monitor System, a hierarchical, real-time breakpoint and triggering system.

The list of benefits goes on and on; but the end result is a faster, easier and more accurate approach to developing, debugging and integrating your design.

To find out more, write Applied Microsystems Corporation, P.O. Box 97002, Redmond, Washington, USA 98073-9702. Or call (800) 426-3925, in WA call (206) 882-2000.

In Europe contact Applied Microsystems Corporation Ltd., Chiltern Court, High Street, Wendover, Aylesbury, Bucks, HP22 6EP, United Kingdom. Telephone 44-(0)-296-625462. AMC-230

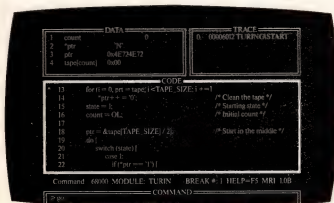


**Applied
Microsystems
Corporation**

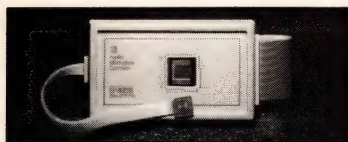
CIRCLE NO 65



High-performance 8, 16 and 32-bit emulation.



Software development tools, including source and symbolic level debuggers.



Motorola, Intel, Zilog and Hitachi microprocessor support.

TECHNOLOGY UPDATE

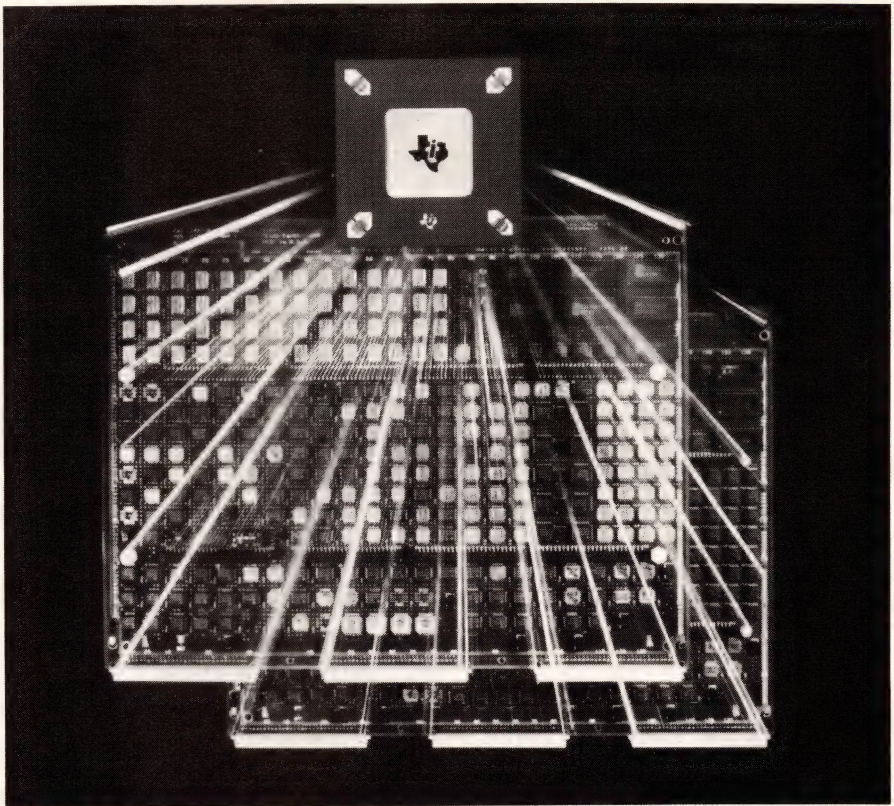
suppose that a computer has control of robotic arms and hands, has definitions of the words "fry," "egg," "pan," "boil," and "stove" in its memory, and has access to those items. We can tell the computer to fry an egg, but we shouldn't be surprised if the computer attempts to perform the task by placing the egg in the pan without breaking the shell. If the computer has to learn that "egg" implies "without the shell" in the context of frying, can we expect it to know that the same word implies "in the shell" in the context of boiling? It is this type of assumption about our environment, not to mention the ambiguity of natural languages, that makes computer simulation of human behavior so difficult to achieve.

You can see, therefore, that AI studies are important for anyone who is designing a system that must take into account the nature of its environment and that must, like a human, attempt to find solutions to problems when the data is incomplete. At a practical level, AI studies have brought new approaches and technological advances to a huge range of disciplines, including natural-language processing, computer vision, speech recognition, robotics, automatic programming and heuristic systems (systems that learn from their experiences).

Expert systems are data-driven

Traditional application programs, such as database managers, are procedure-driven. That is, they process the information contained in the database according to a fixed set of instructions. Knowledge-based programs, such as expert systems, are far more flexible; they dynamically determine the sequence of rules to be employed while the program is running, and they do so on the basis of both the desired result and the data that's available to them.

Another difference between procedural programs and expert systems is that the former use only forward chaining to determine the



Lisp programs run fastest on a machine whose native language is Lisp. The heart of Texas Instruments' Explorer workstation is this Lisp CPU chip.

sequence of rules the program employs. That is, they proceed from a fixed set of input data to a fixed goal by applying the rules in sequence. Expert systems can also employ backward chaining; that is, they can start from a particular goal, break it into several subgoals, and work backward through the rules until the available data fits one or more of the subgoals. If the system does not find an exact match, it can ask for more data; if additional data is not available, the system can indicate the closeness of the match as a percentage, and can also—at any time—explain the rules that it applied in order to reach a particular conclusion or recommendation.

An expert system consists of two major components. One is a *knowledge base* that can store data in a form that allows the representation of both facts (declarative knowledge) and rules of thumb for relating them (procedural knowledge). The other is a *control structure* (also called a *rule interpreter* or an *infer-*

ence engine) that determines the manner in which the knowledge is to be used.

An expert-system shell contains an empty knowledge base and an inference engine, but also contains an editor or some other means of eliciting and storing items of both declarative and procedural knowledge. The vendor usually licenses both a development system that includes all three major components (and often some helpful utility programs) and a run-time system that consists only of the knowledge-base framework and the inference engine. You can distribute the run-time system as part of any expert system that you develop with the package.

Inexpensive expert-system shells

A typical example is the Exsys shell from Exsys Inc. Its development system for IBM PCs and compatibles costs \$395; its run-time system costs \$600 for unlimited distribution. You can license both

TECHNOLOGY UPDATE

systems for \$900. The shell is written in C, which gives it high execution speed and efficient memory use. If your PC has 640k bytes of RAM, you can develop systems with as many as 5000 rules. The inference engine can use both forward and backward chaining; you can exchange data with most spreadsheets and database programs; and you enter all input in English text, in algebraic notation, or via menu selections. You can get a demonstration disk that has all the features of the full system (including a printed manual, sample expert systems, and a tutorial on how to create expert systems) but allows you to save only 25 rules to disk. The demo disk costs \$15.

Costly expert-system shells

A much more elaborate, flexible, and costly development system is GoldWorks from Gold Hill Computers Inc. This system runs on 80286- or 80386-based machines that have at least 512k bytes of main memory and 5M bytes of extended memory. The system is a frame-based one, which provides flexibility of knowledge representation—in other

words, each data object is not only named, but also contains descriptions of all its parts and their attributes (such as quantity, color, relationships to other parts, etc). The inference engine allows both forward and backward chaining, and provides control mechanisms that handle user-defined rule priorities and certainty factors, as well as rule-inspecting and -debugging facilities. You can exchange data with spreadsheets and database managers. In addition, you get extensive tutorial material, not only on how to create expert systems but also on Lisp programming and AI strategies. The developer's interface includes an Emacs-like editor, a large-memory Lisp interpreter and compiler, and a variety of debugging tools. Prices start at \$7500.

An optional training program called Axle, also from Gold Hill, gives a stage-by-stage demonstration of the development of four different types of expert systems: a manufacturing system, an aerospace system, and two planning systems, one for an industrial application, and the other for oil exploration. These sample systems

include methods for diagnosing equipment malfunctions and help in making decisions about tasks and resources. The program runs on 80286- and 80386-based PCs, and costs \$1995.

Although Texas Instruments (TI) is best known in the AI field for software that runs on the TI Explorer workstation, whose native language is Lisp, TI also provides expert-system shells that run on PCs and compatibles. At the low end of the company's Personal Consultant series is PC Easy, which runs on PCs or PC/XTs and costs \$495. At the high end is PC Plus, which runs on 80286- or 80386-based machines and costs \$2950. Knowledge bases created with PC Easy are upwardly compatible with PC Plus knowledge bases, and both are compatible with the Explorer Symbolic Processing System. TI supplies demonstration disks for PC Easy and Plus.

An interesting newcomer to the ranks of expert-system shells is CxPERT (\$495 from Software Plus). Like other shells, it provides you with a knowledge-representation framework, user-interface mod-

An AI reading list

If you want to know more about artificial intelligence, you'll find the following publications informative. They can also direct you to further, more specialized reading.

1. *AI Expert*, CL Publications Inc, 650 Fifth St, Suite 311, San Francisco, CA 94107. Phone (415) 957-9353. \$27/year (12 issues). Interesting for both the professional and the novice in the AI field. Rather similar in character to *Computer Language*, it addresses both general problems and the tricks of the trade.
2. *AI Magazine*, American Association for Artificial Intelligence (AAAI), 445 Burgess Dr, Menlo Park, CA 94025. Phone (415) 328-3123. Yearly membership, \$25; 5 issues/year. The professional journal of scientists involved in AI research. A must if you're involved in AI projects.
3. *AI Trends*, DM Data Inc, 6900 E Camelback Rd, Suite 1000, Scottsdale, AZ 85251. Phone (602)

945-9620. In the US, \$295/year (12 issues); elsewhere, \$345/year. Describes trends, important issues, and the administrative and economic vicissitudes of the major players in the AI field.

4. *Artificial Intelligence Letter*, Texas Instruments, Data Systems Group, Box 2909, M/S 2222, Austin, TX 78769. Includes case histories, the viewpoints of eminent AI experts, and a conference calendar.

5. *Understanding Artificial Intelligence*, by Henry C Mishkoff (1985). The Texas Instruments Learning Center, Box 225474, MS-8218, Dallas, TX 75265. \$14.95. A first-class introduction to the AI field, with clear descriptions of the various branches, the issues involved, and some of the products. The book was originally issued in conjunction with the first of the TI-sponsored Satellite Seminars on AI. Highly recommended.

Stop Wasting Power



New CMOS array features the lowest power dissipation: $8\mu\text{W}/\text{Gate}/\text{MHz}$

Raytheon's newest CMOS array family, the RL1000, helps you achieve optimum power performance. It offers the lowest power dissipation available—at high densities—without sacrificing speed.

□ **Lowest Power:** Raytheon's $8\mu\text{W}/\text{gate}/\text{MHz}$ CMOS arrays, with 1.0 micron effective channel lengths, have available densities ranging from 5670 to 20,440 gates. With 20 tracks per channel instead of the standard 16, gate utilization is typically 90 percent or better.

□ **High Speed:** At 0.3 ns unloaded inverter delay, this low-power, high-speed array family is perfect for portable equipment or where power sources are limited.

□ **Other features:** The RL1000 series, with symmetrical switching delays, operates at 250 MHz flip-flop frequency and is TTL/CMOS compatible.

□ **Packaging:** All packaging options are available. And Raytheon's design support includes an extensive macrocell library on major workstations.

□ **Also available in CMOS:**

- Approved VHSIC PHASE I gate array: RVG 1.25 family
- Second source for LSI Logic Inc.'s LL7000 Series: RL7000

Call Raytheon for access to the right CMOS technology. Your success is our first priority.

Raytheon Company
Semiconductor Division
350 Ellis Street
Mountain View, CA 94039-7016
(415) 966-7716

Raytheon

Where quality starts with fundamentals.

ules, and an inference engine that allows several layers of backward chaining. According to one reviewer, the forward-chaining feature is somewhat rudimentary, but it's nevertheless very flexible. The unusual feature of this shell, which is written in C, is that it encourages you to use standard C code to perform tasks that the high-level constructs don't support. You create knowledge-base modules in a mixture of C and a knowledge-representation language (KRL) source code; these modules contain the rules, attributes, menu text, and logic that compose the expert system. The KRL compiler processes these modules to produce a C source file and a header file, which you compile with the Microsoft or Lattice compiler. You can then link your object modules to the object libraries supplied with the shell, as well as to other C programs or routines.

Neural networks open new doors

Neural networks have probably existed in rudimentary form for a number of years, but have only recently become practical. They are still immature, but—theoretically—they promise dramatic advances in the technology of pattern recognition. What's important about them is that they're capable of learning, from examples, to recognize not only specific shapes and patterns, but also a gestalt. In other words, they can learn to recognize the clues that allow us, for example, to abstract the concept "dog" from the specifics "Doberman" and "Yorkshire terrier," despite the differences in size, shape, and hair texture. Only three neural-network systems are as yet available for PCs, and they all require the computing power and speed of an 80286-based machine.

At the low end of the scale is Netwurkz (\$79.95) from DAIR Computer Systems. This product is limited in scope and capability, but it serves as a demonstration of the more-obvious properties of neural

networks. It does, however, provide facilities that let you develop simple programs other than those supplied as examples. Another demonstration and learning system is Awareness (\$250) from Neural Systems.

At the high end is the NDS system from Nestor Inc (\$7500 for the PC/AT version). The NDS system emulates the action, as we currently understand it, of the biological neural networks used by the human learning and classification processes. It will learn to recognize images such as industrial objects, alphanumeric characters, and signatures if you present it with examples of those images. The package is menu driven and highly interactive. It is written in C, and it includes extensive diagnostic facilities for fine-tuning its recognition performance. It also provides an interface to Datacube's (Peabody, MA) MaxiVision image-processing hardware for the PC/AT. The combination creates an intelligent vision system that manufacturers can employ in factory automation at a cost of less than \$20,000.

Tsk! Tsk! Such language!

Hardly any programming topic (except one's choice of editor) can so reliably start a heated discussion as one's choice of programming language. Opinions on AI languages just add fuel to the fire. The traditional language for AI programming has for many years been Lisp, because its features make it admirably suited to handling software objects that embody both attributes and procedures specific to those objects. In the last few years, however, other languages have started to edge Lisp out of its formerly pre-eminent position. Even such a dyed-in-the-wool Lisp proponent as Symbolics Inc is starting to rewrite its AI products in the C language, for the sake of portability.

There are several reasons for this shift. First, Lisp is a memory hog; it is liable to create many noncontiguous islands of abandoned data to

which pointers no longer exist. Periodically, the memory must be homogenized into contiguous used and free areas by a time-consuming process called "garbage collection." Second, Lisp runs fastest on machines whose native language is Lisp. Until Texas Instruments produced the Explorer CPU chip, and Symbolics came out with the Ivory CPU chip, the only dedicated Lisp machines were of mainframe size and power, and they had corresponding price tags. Third, Lisp has fragmented into many dialects, which certainly doesn't make for portability. And, last, the syntax is not easy. Experts will assure you that it's possible to write a Lisp program that other people can read and understand easily, but their antagonists will warn you that you might get "Lost In Silly Parentheses."

If you're already a Lisp fan, consider the versions available for the PC, which range from TI's \$95 PC Scheme, through the \$495 Star Sapphire version of Common Lisp (Sapiens Software), to Gold Hill's Golden Common Lisp for 80286-based machines at \$1995. The Star Sapphire package is interesting because it compiles programs to C; to use it, you'll need 640k bytes of RAM, a hard-disk drive, and a C compiler that supports the Huge memory model. For those who want to try out Lisp at minimal expense, however, there's a public-domain, object-oriented dialect called XLisp that you can download from many PC-based bulletin boards for the price of a phone call.

Object-oriented languages

The principal rival of Lisp in the AI field is probably C, partly because of its steadily increasing popularity as an all-purpose language, and partly because AT&T's superset of the language, called C++, is readily available for the PC. This augmented version of C is an object-oriented language. It provides such features as classes, inheritance,

TECHNOLOGY UPDATE

member functions, constructors and destructors, data hiding, and data abstraction, which are virtually essential for any sophisticated AI programming. In particular, the "classes" feature lets you create modules that contain their own data and data-related operations; you can compile these modules independently, just as you would do in a Modula-2 system. You can save your modules in separate files and reuse them in other C++ programs. C++ usually comes in the form of a translator from C++ to standard C source code, so you'll be able to use your existing C compiler. C++ translators are available from Guidelines Software Inc (\$295) and Oasys. The Oasys version is available for many different machines and their most common C compilers. It costs \$495.

If you just want to experiment with the C++ language, you can do so inexpensively by using Zortech's \$99.95 compiler. Unlike the other packages, which translate C++ code to standard C source code for later compilation and linking,

Zortech's product is a true compiler that generates relocatable object modules for 8088-based machines. Zortech can also supply Bjarne Stroustrup's book *The C++ Programming Language* (\$29.95), which contains the standard specifications of the C++ language. Stroustrup designed the language.

Prolog, the new AI language

Prolog is a nonprocedural programming language. It is conceptually simple and extremely powerful, but so different from procedural languages such as Lisp and C that it's difficult to learn, especially if you're experienced in using a procedural language—you have to develop a totally different way of thinking in order to use it effectively. The language is object-oriented, and it embodies such features as backtracking, which allows the execution of statements to take place not only from top to bottom and left to right (as in procedural languages), but also from right to left and from bottom to top.

The two major implementations of Prolog for IBM PCs and compatible computers are Arity/Prolog and Turbo-Prolog. Arity's package (\$650) includes both a compiler and an interpreter. You can also get the Arity/Expert System and Arity/SQL as options for \$295 each.

Borland's Turbo Prolog 2.0 (\$149.95) also runs on IBM PCs, PS/2s, and compatibles. You must have at least 348k bytes of RAM (640k bytes are recommended) and two floppy-disk drives (a hard-disk drive is recommended). The package allows you to work with multiple internal databases, as well as with an external database system, so you can develop very large databases. It also includes the source code (written entirely in Turbo Prolog) of a Prolog interpreter. There are step-by-step instructions for including the interpreter in your own application programs and for customizing it to suit your needs. The package provides windowing facilities, and is entirely compatible with Turbo C, so that programs written

For more information . . .

For more information on the AI software development tools discussed in this article, contact the following manufacturers directly, circle the appropriate numbers on the Information Retrieval Service card, or use EDN's Express Request service.

Arity Corp
30 Domino Dr
Concord, MA 01742
(617) 371-1243
Circle No 725

Borland International
4585 Scotts Valley Dr
Scotts Valley, CA 95066
(408) 438-8400
Circle No 726

DAIR Computer Systems
3440 Kenneth Dr
Palo Alto, CA 94303
(415) 494-7081
Circle No 727

Datacube Inc
4 Dearborn Rd
Peabody, MA 01960
(617) 535-6644
Circle No 728

Digitalk Inc
5200 W Century Blvd
Los Angeles, CA 90045
(213) 645-1082
Circle No 729

Exsys Inc
Box 75158
Contr Sta 14
Albuquerque, NM 87194
(505) 836-6676
Circle No 730

Gold Hill Computers Inc
26 Lansdowne St
Cambridge, MA 02139
(617) 621-3300
Circle No 731

Guidelines Software Inc
Box 749 #CL
Orinda, CA 94563
(415) 254-9183
Circle No 732

Nestor Inc
1 Richmond Sq
Providence, RI 02906
(401) 331-9640
Circle No 733

Neural Systems Inc
2827 W 43rd Ave
Vancouver, BC V6N 3H9, Canada
(604) 263-3667
Circle No 734

Oasys
230 Second Ave
Waltham, MA 02154
(617) 890-7889
Circle No 735

Sapiens Software
236 Mora St
Santa Cruz, CA 95060
(408) 458-1990
Circle No 736

Softsmarts Inc
4 Skyline Rd
Woodside, CA 94062
(415) 327-8100
Circle No 737

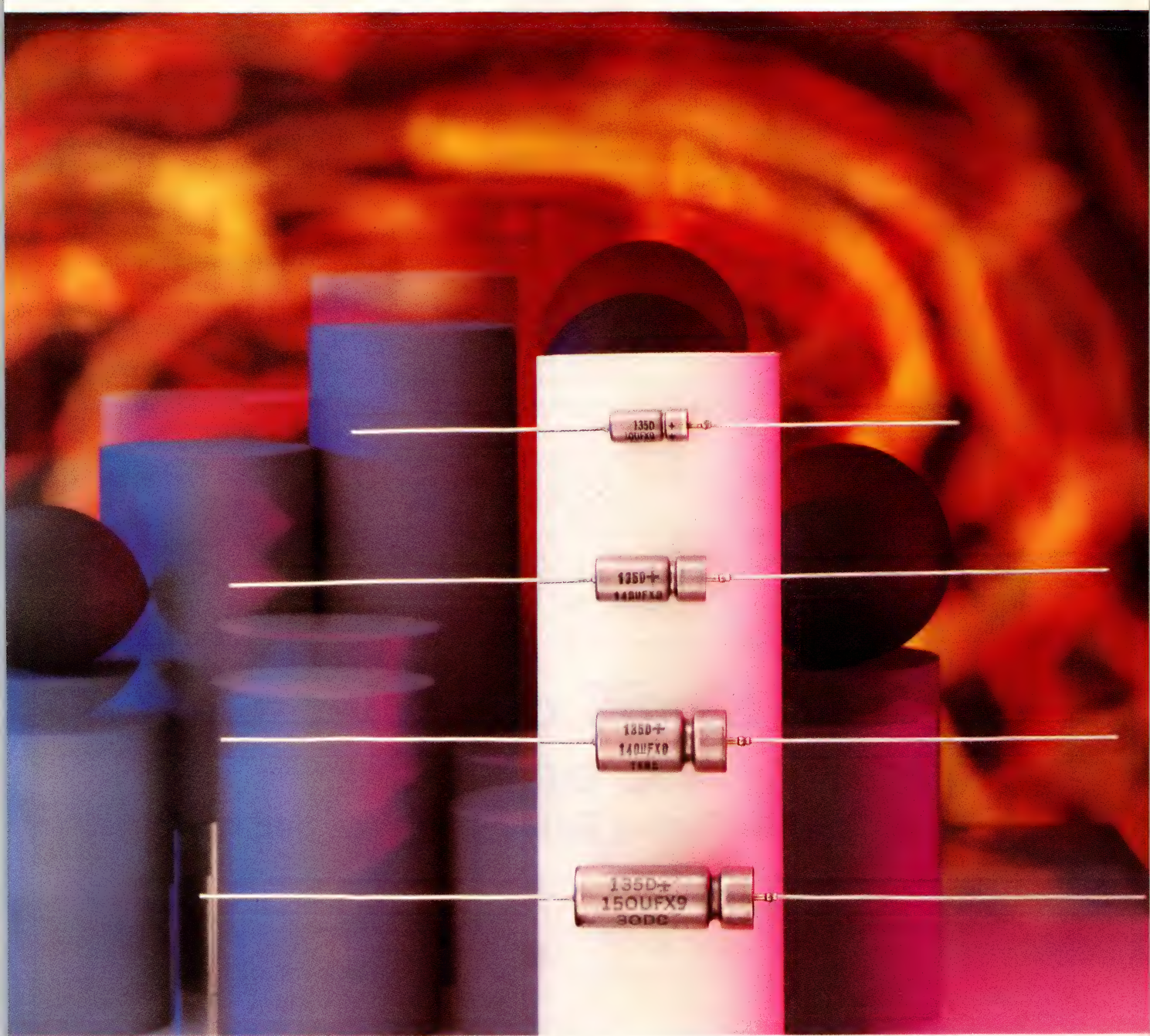
Software Plus
1652 Albermarle Dr
Crofton, MD 21114
(301) 261-0264
Circle No 738

Stony Brook Software Inc
Forest Rd
Wilton, NH 03086
(603) 654-2525
Circle No 739

Texas Instruments Inc
AI Software Marketing Group,
M/S 2244
Data Systems Group
Box 2909
Austin, TX 78769
(512) 250-7000
Circle No 740

Zortech Inc
361 Massachusetts Ave
Arlington, MA 02174
(617) 646-6703
Circle No 741

SURVIVABILITY.



4SX-3159R2

SPRAGUE TANTALUMS CAN TAKE THE SHAKES.

As you might expect, Sprague was first to offer Option H 'High Random Vibration and High Shock' Mil Style CLR79 Tantalum-cased Tantalum Capacitors. They're made to MIL-C-39006/22 in *all* four case sizes (T1 thru T4) and in *all* voltages (6 thru 125 VDC). The 51g random vibration capability of Type 135D/Mil Style CLR79 capacitors is provided by unique cathode construction at *no extra cost to users*.

Performance characteristics are backed with over 50 million hours of documented testing. For Engineering Bulletin 3760B, write to Technical Literature Service, Sprague Electric Company, P.O. Box 9102, Mansfield, MA 02048-9102.



CIRCLE NO 68

in either of the languages can call routines (or complete programs) that are written in the other language.

Smalltalk and Modula-2

Two other languages that are well suited to AI-related projects are Smalltalk and Modula-2, though at present these are less widely known and used than Lisp and Prolog. Both are object-oriented languages, and both allow you to construct independently compiled, reusable software modules. Smalltalk comes in two versions for IBM PCs: a full version of the original language (developed at the Xerox PARC research center), which comes from Softsmarts and costs \$995; and a subset that comes from Digitalk Inc and costs \$99. This subset is not a toy—all the basic features are present, and you can use it to develop commercially useful applications.

Many Modula-2 compilers are

available for PCs (Ref 2). Typical compilers are Stony Brook Modula-2 (\$345) and QuickMod (\$95). Together they form an integrated compiler and interpreter package somewhat similar to Turbo Prolog. Both come from Stony Brook Software Inc.

The developers mentioned represent only a small portion of the entire market for AI-related products. More than 50 vendors now offer such products, most of which are expert-system shells and language-development tools. If neural networks live up to their promise, you can expect to see vendors applying them to improve automated manufacturing equipment and to fulfill part of the modern technological wish list—by permitting the development of such items as a voice-activated typewriter and a reliable language translator. Artificial intelligence may yet prove to be the dreamchild of the 50s that will come of age in the 90s.

EDN

References

1. Rich, Elaine, *Artificial Intelligence*, McGraw-Hill, New York, NY, 1981, pg 1.
2. Anderson, Brian, "Modula-2's design simplifies programming and compilation," *EDN*, March 3, 1988, pg 147.
3. Conner, Doug, "Data transformation explains the basics of neural networks," *EDN*, May 12, 1988, pg 138.

Article Interest Quotient
(Circle One)

High 515 Medium 516 Low 517

To: Intel 80x86 compiler users — PC or VAX™

Ada

Subject: Reducing Debugging time and cost

Do you debug 8086-family software using emulators? Then please consider our high-level cross debugger, MicroSCOPE™. It can save time by giving you full source-display in C, Pascal, PL/M, FORTRAN, and Ada with emulators from Intel™, Tektronix, and others.

**And MicroSCOPE can slash cost
by controlling your target directly
without an emulator.**

With or without an emulator, you get a source display window, 100 software breakpoints (plus any emulator breakpoints), single step, movie mode, evaluation of complex expressions, variable assignment, a disassembler, target I/O to host files, and many more advanced features.

MicroSCOPE debugs real-time target systems based on the 8086, 80186, and the 80286 in both real and protected mode. It works with compilers from Intel, First Systems, Softech and DDCI Ada, and with any others using Intel symbols.

Free demo disk

Please call for a free demo for your PC.

(213) 328-6730



FIRST SYSTEMS CORPORATION
2275 West Torrance Blvd.
Torrance, CA 90501
Telex: 298086 (FIRSYS)

Trademarks: MicroSCOPE, First Systems Corporation; VAX, Digital Equipment Corporation; Intel, Intel Corporation. © 1988 First Systems Corporation.



**Get hardware and software
working together...**

...and you'll reach levels you've ne



Harris Introduces Real Time Express™

**The first microcontroller
optimized for real time, will put
your systems on the fast track!**

Every designer is looking for a faster system. But the special demands of real-time applications require you to look beyond MIPS—to predictability, repeatability and responsiveness. Because in a real-time world, a late answer is a wrong answer.

Now there's a solution addressing all your performance parameters: our Real Time Express (RTX™) family. Combining the integration of a microcontroller and the speed of a RISC processor.

Real-Time Tradeoffs Before RTX™

Traditional microprocessors sacrifice predictability and external response to achieve high

instruction-execution speeds, and they can't switch tasks quickly with minimum overhead.

Traditional microprocessors lack flexible partitioning between hardware and software to meet critical timing requirements. You can't easily extend their architectures to accommodate application-specific needs, either.

Real-Time Software: Hard Without RTX™

Today's real-time software environment restricts designers' productivity. They have no choice but to mix high-level and assembly language — sometimes microcode, too — during program development. To achieve real-time performance, they must program and debug the most complex tasks at the lowest level. The result: long development cycles, difficult debugging and high maintenance costs.

RTX 2000™ Performance

Processor Clock Speed (MHz)	Typical Instruction Rate (MIPS)*	Power Dissipation (mW)	Interrupt Latency (μs)	Conditional Branch (μs)	16 x 16 Multiply (μs)	ASIC Bus™ Bandwidth (Mbytes/Sec)	Subroutine Call/Return Overhead (μs)
10	15.0	400	0.4	0.10	0.10	20	0.10
8	12.0	320	0.5	0.12	0.12	16	0.12
5	7.5	200	0.8	0.20	0.20	10	0.20
1	1.5	40	4.0	1.00	1.00	2	1.00

*Instruction Rate Measured In Millions Of Instructions Per Second.

ch performance ver dreamed of.

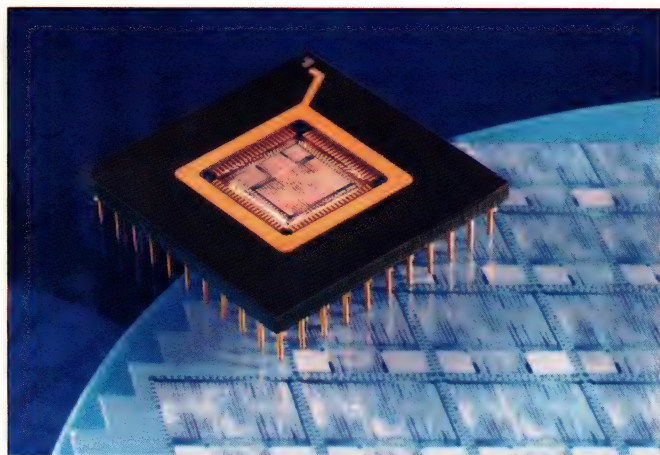


The RTX™ Solution: No More Performance Penalties

The Real Time Express™ family of general purpose, application-specific and semicustom products offers you microcontroller integration and RISC processor speed — for a fraction of the power of conventional designs.

It achieves performance through simplicity and parallelism, using an innovative dual-stack Quad Bus™ architecture with no caches or pipelines.

RTX™ frees you to program your entire application in a structured, high-level language (C, Forth, Prolog) without traditional performance penalties.



The Little Engine That Does: Based on proven macro cells, the Harris RTX is fully integrated into a CAD system, adding flexibility and reducing risk in semicustom designs.

RTX 2000/2001™ Features

Feature	RTX 2000	RTX 2001
Timer/Counters (on-chip)	3 ea. — 16 bit	3 ea. — 16 bit
Interrupt Controller (on-chip)	NMI and 13 Maskable (Expandable off-chip)	NMI and 13 Maskable (Expandable off-chip)
Memory (on-chip)	256 x 16 Parameter Stack 256 x 21 Return Stack	64 x 16 Parameter Stack 64 x 21 Return Stack
Wait State Controller (on-chip)	Yes	Yes
ASIC Bus™	16 bit	16 bit
16 x 16 Multiply	Single Cycle	20 Cycle
32/16 Divide	21 Cycle	21 Cycle
32/16 Square Root	25 Cycle	25 Cycle
Address Range	1 Mbyte	1 Mbyte
Data Bus	16 bit	16 bit
Byte Operations	Yes	Yes
Package	84 pins	84 pins
883C Compliant	1Q CY89	Not Planned
Semicustom Migration Path	Yes	Yes
Rad-Hard Migration Path	Yes	Not Planned
32 bit Migration Path	Yes	Yes
Development System	Yes	Yes
Forth Compiler	Now	Now
C Compiler	4Q CY88	4Q CY88
Prolog Compiler	1Q CY89	1Q CY89



A better hardware-to-software balance can make you 10 times more productive.

You'll boost productivity by debugging interactively — at full speed — with full symbolic debug support. Powerful debugging tools you can use on a low cost PC.

Now you can integrate hardware and software, and debug without investing in costly, complex In-Circuit Emulators (ICE).

It's everything you've wanted in a real-time microcontroller — rapid interrupt response, predictable timing, fast context switch, hardware extensibility (via a unique ASIC Bus™). And our

16-bit RTX 2000™ and RTX 2001™ are just the start. To respond to the diversity of your real-time applications, we'll be announcing a broad family of RTX™ products, among them fixed and floating point versions, and a 32-bit model.

Find out more about how you can move more of your hardware into software — and get them working together like never before.

Contact us for technical briefs or to reserve a spot at an RTX™ seminar near you.

In U.S.: 1-800-4-HARRIS Ext. 1288 (literature)

Ext. 1299 (seminars)

In Canada: 1-800-344-2444 Ext. 1288 (literature)

Ext. 1299 (seminars)

Sales Offices

U.S. HEADQUARTERS

Harris Semiconductor
2401 Palm Bay Road
Palm Bay, Florida 32905

EUROPEAN HEADQUARTERS

Harris Systems Ltd.
Semiconductor Sector
Eskdale Road
Winnersh Triangle
Wokingham RG11 5TR
Berkshire
United Kingdom
TEL: 0734-698787

FAR EAST HEADQUARTERS

Harris K.K.
Shinjuku NS Bldg. Box 6153
2-4-1 Nishi-Shinjuku
Shinjuku-Ku, Tokyo 16 Japan
TEL: 81-3-345-8911

DISTRIBUTORS IN U.S.A.

Anthem Electronics
Falcon Electronics
Hall-Mark Electronics

Hamilton/Avnet Corporation
Schweber Electronics

DISTRIBUTORS IN CANADA

Hamilton/Avnet Corporation
Semad Electronics

**IN REAL-TIME CONTROL,
THE NAME IS
HARRIS**

Harris Semiconductor: Analog - CMOS Digital
Gallium Arsenide - Semicustom - Custom



Reorder Number: 6AD-5030
©Harris Corporation, July 1988
Printed in U.S.A.

Real Time Express, RTX, RTX 2000,
RTX 2001, ASIC Bus, and Quad Bus
are trademarks of Harris Corporation.

UP TILL NOW, THERE HAS BEEN ONE DRAWBACK TO SCAN-BASED ASIC DESIGN VERIFICATION SYSTEMS: YOU COULDN'T GET ONE.

Since you couldn't get one—to verify first silicon—you had to invent your own. Or borrow an expensive ATE system from the Production Department. Good luck.

Well, your luck has changed. With the ScanMaster DV6005—and a technique of wafer signature analysis—you can verify the integrity of your scan-based circuit, and quickly pinpoint design problems. At the node level.

Consider these features:

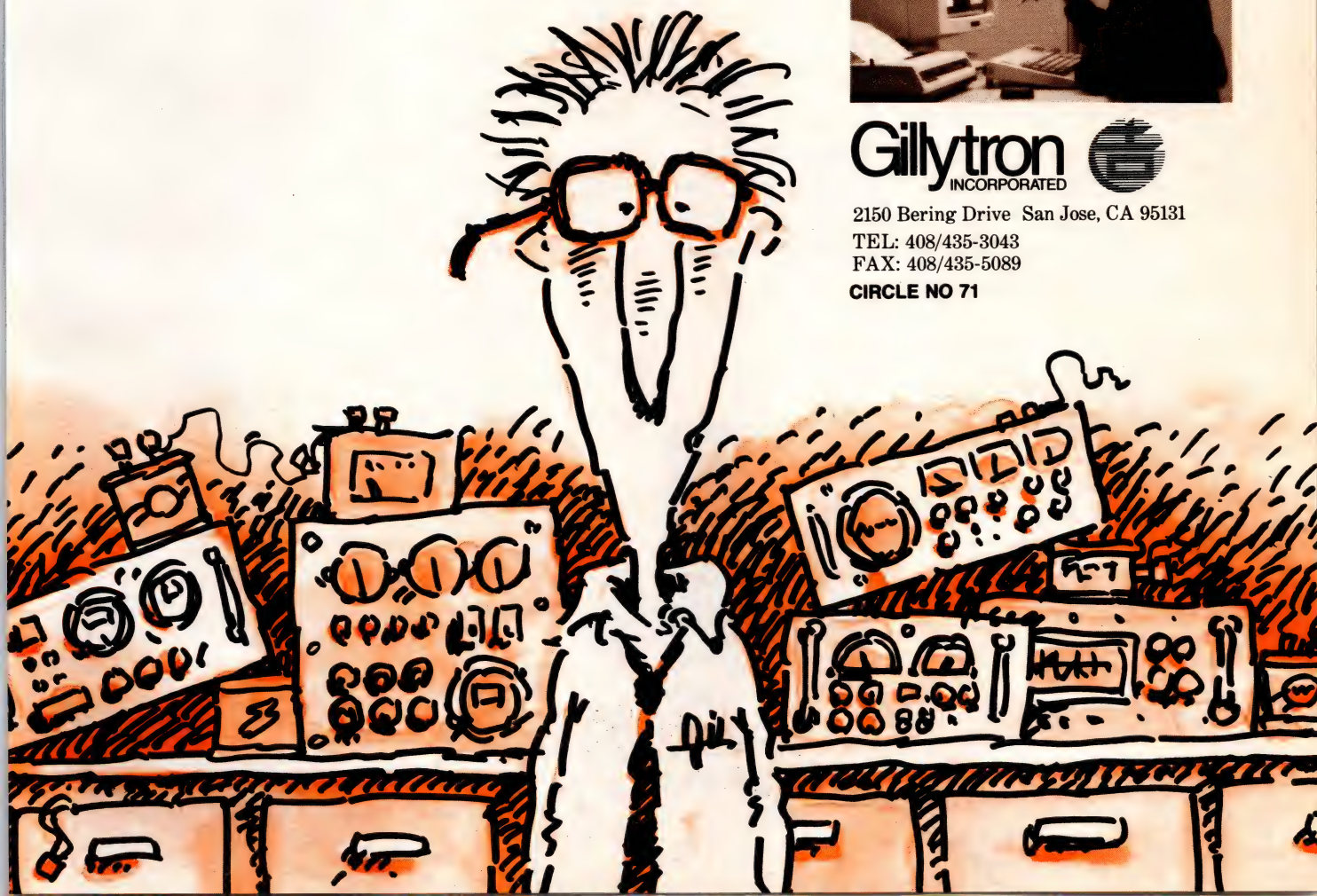
- >99% single stuck-at-fault coverage.
- Ring-frequency AC evaluation and complete DC parametric test.
- Direct link to ATPG.
- Menu-driven software and "C"-like test programs.
- Rapid isolation of node-level faults.
- A software pin-map which simplifies hardware fixturing.
- Flexible interactive software provides fast programming generation.

At \$125,000, the DV6005 is not only inexpensive at the beginning, it is a stand-alone system that can be *expanded directly to an automated wafer-, device- or board-production tester—with 1792-pin capability.*



Gillytron
INCORPORATED

2150 Bering Drive San Jose, CA 95131
TEL: 408/435-3043
FAX: 408/435-5089
CIRCLE NO 71



Now WSI Puts Performance Into Every Design

*New 256K to 1M bit
EPROMs.*

All Under 100ns.

*All Available
Now.*

WSI puts performance into your hands. With a complete family of high-speed, non-volatile memory devices that let you realize the true zero-wait-state potential of today's high-end MPUs, DSPs, and embedded controllers.

WSI's L-Series CMOS EPROMs:
High density.
High performance.
High value.

WSI's new L-Series CMOS EPROMs are ideal for high-performance applications, including 16-MHz 68020 and 1750A-type systems. Available in 32K x 8 (WS27C256L), 64K x 8 (WS27C512L), and 128K x 8 (WS27C010L)



architectures, WSI's L-Series NVMs open the realm of sub-100ns performance to everyone.

**WSI's
F-Series CMOS
EPROMs:**
Byte-wide.
Word-wide.
Super-fast.

WSI's F-Series brings high-speed, high-density NVM to new-generation systems—including embedded controllers based on 12- and 16-MHz 80386/80376

MPUs, and 16- or 20-MHz RISC processors. And WSI's word-wide architecture lets you pack more performance into less board space.

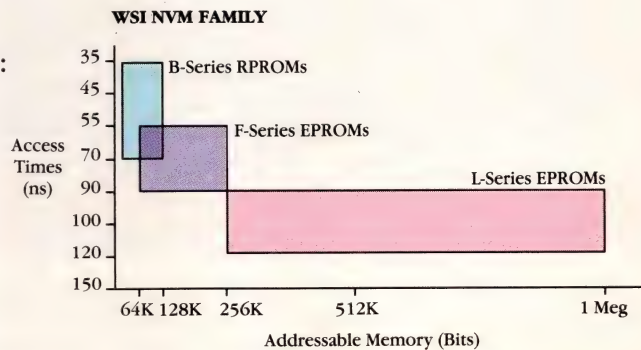
© 1988 WaferScale Integration, Inc.

Performance Memory Designer's Hands.

WSI's B-Series CMOS RPROMs™:

Better than
bipolar.
Reprogram-
mable, too.
Available in
densities
ranging from
16K to 256K

bits, WSI's
B-Series Repro-
grammable PROMs
give designers of
20- and 40-MHz
TMS320 DSPs and
other high-speed



systems ultra-high performance. And they
consume just a fraction of the power of
their bipolar counterparts.

Feel the power of performance.

Whether your application is commercial or
mil-spec, you can possess the power of WSI
performance right now.

Call today:

**800/331-1030,
extension 234**

In California, call:
**800/323-3939,
extension 234.**

Part No.	Fastest Commercial Speed	Fastest Military Speed	Type
L-Series			
WS27C010L	90ns	120ns	128K x 8 CMOS EPROM
WS27C512L	90ns	100ns	64K x 8 CMOS EPROM
WS27C256L	90ns	100ns	32K x 8 CMOS EPROM
F-Series			
WS57C256F	55ns	70ns	32K x 8 CMOS EPROM
WS57C257	55ns	70ns	16K x 16 CMOS EPROM
WS57C65	55ns	70ns	4K x 16 CMOS EPROM
WS57C64F	55ns	70ns	8K x 8 CMOS EPROM
B-Series			
WS57C51B	40ns	50ns	16K x 8 CMOS RPROM
WS57C49B	35ns	45ns	8K x 8 CMOS RPROM
WS57C43B	35ns	45ns	4K x 8 CMOS RPROM
WS57C191/291B	35ns	45ns	2K x 8 CMOS RPROM



WAFERSCALE INTEGRATION, INC.

47280 Kato Road
Fremont, California 94538
415/656-5400

RPROM is a trademark of WaferScale Integration, Inc.

The "Look and Feel" CAE Users Have Been Looking For

On-Screen Prompt line makes it easy to find the feature you're looking for.

Hierarchical Menus eliminate keyboard commands.

Action Button selects functions.

Menu Button toggles between menu and graphics.

Pan Button Redraws screen around cursor location.

Command Line displays selected function.

EE Designer III supports workstation-quality graphics up to 1280 x 1024 resolution, or uses standard VGA, EGA, or CGA color graphics.

EE Designer III takes advantage of all 3 mouse buttons for maximum operating speed and throughput.

Introducing EE Designer III™

The first ergonomic PC-based CAE software system

The fact is that today's CAE software systems have a lot of features. The problem is that you have to read a huge manual or go to a HELP screen to find the feature you need.

Finally, an integrated desktop CAE software system with all the features you need plus an ergonomic user interface that lets you easily find and access them.

EE Designer III combines on-screen function prompts with a graphic-based hierarchical menu structure.

Outside North America Contact:

BETRONEX
ELEKTRONIK AB

Box 1337
S-181 25 LIDINGO, Sweden
Tel: +46 8 7679205
Fax: +46 8 7318118

EE Designer III sets the price-performance standard for CAE software.

- Supports L/I/M EMS Memory for Expanded Database Capabilities
- On-Line Netlist Capture
- Forward and Back-Annotation of Multipage Schematics
- Analog and Digital Circuit Simulation
- Full SMT Support
- 1 mil Grid Resolution
- 45° Memory AutoRouting
- Fabrication/Assembly Drawing Support

So whether you're capturing a schematic or Auto-Routing your printed circuit board you can always find the function you need.

The EE Designer series of products is distributed worldwide by a combination of Visionics Corporation in North America and Betronex Group in Europe, Asia, Australia and South America.

Join the family of over 7000 worldwide users who have found that the EE Designer series of products get the job done.

In North America Contact:

VISIONICS®
CORPORATION

343 Gibraltar Drive
Sunnyvale, CA 94089
(408) 745-1551 1-800-553-1177
Telex: 346352 Fax: (408) 734-9012

Dynamic-RAM-controller ICs squeeze maximum performance from DRAMs

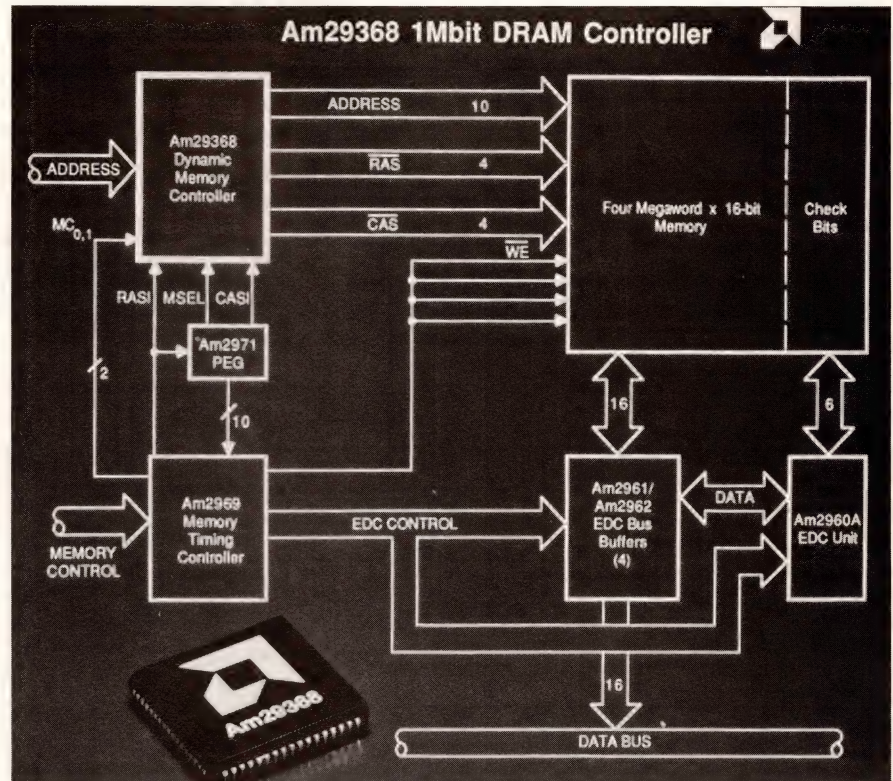
Steven H Leibson,
Regional Editor

Despite this year's acute parts shortage and the subsequent price increase, dynamic RAMs (DRAMs) still cost less than static RAMs (SRAMs) on a bit-by-bit basis, and they still take up less room on your pc board. However, DRAMs employ address-multiplexing and capacitive-storage techniques, which make them fussy about timing: The wrong timing signals can make them lose data, causing you thorny problems when you design DRAM controllers for memory subsystems.

For years, engineers have designed DRAM-controller circuits with general-purpose MSI components and delay lines. The current crop of DRAM-controller ICs, however, solves DRAMs' timing problems much more efficiently in terms of cost, pc-board space, and signal quality. In addition, many of the latest parts can help you take advantage of advanced DRAM features such as burst access. The cost of these controller ICs has dropped over the past few years, so they represent a more attractive alternative than ever to designing your own controller.

Critical timing requirements

When you use DRAMs in a system design, your controller circuitry must satisfy three critical timing requirements: RAS (row address strobe) and CAS (column address strobe) sequencing, refresh, and RAS precharge. DRAMs are also quite sensitive to signal undershoot. If your circuitry does not meet these DRAM timing and signal requirements, your system either will not



DRAM controllers that lack RAS/CAS- or refresh-timing generators—such as AMD's Am29368 DRAM-controller IC—can give you more flexibility to meet unusual DRAM sequencing requirements, but at a cost—they need additional ICs to create the timing signals that generate the sequencing.

work at all—if you're lucky—or will exhibit recurring, intermittent memory lapses. These failures are tough problems to troubleshoot, so you should take extraordinary measures to prevent them when designing a DRAM-based subsystem.

DRAM timing basics

The DRAM multiplexed-addressing sequence boils down to the same four steps for both read and write cycles. First, you present a row address, comprising half of the memory location's address bits, to the DRAMs' address inputs. Then you assert RAS, causing the DRAM to latch the row address. Next, you

present the column address—the second half of the memory address—to the DRAM's address inputs. Finally, you assert CAS, causing the DRAM to latch the column address. The address lines' timing must meet an assortment of setup-and-hold-time specifications with respect to both RAS and CAS.

One way to classify DRAM-controller ICs is by the presence or absence of on-chip RAS/CAS timing. Both types of controller have been available for some time (a selection of both appears in **Table 1**). Controllers with on-chip timing include the Texas Instruments (TI) THCT4502B and SN74ACT4503 and

TECHNOLOGY UPDATE

the National Semiconductor DP8400 controller series. TI's controllers generate the RAS/address/CAS sequencing with synchronous, clocked circuits, and National Semiconductor's devices incorporate precise silicon delay lines. In addition, you can control the timing on the National Semiconductor parts with external circuitry.

Some DRAM controllers contain no timing circuits; they provide RAS, CAS, and multiplexer-control inputs that permit other circuitry to control the timing. One such device

is the Am2968A from Advanced Micro Devices (AMD); it was one of the first DRAM-controller ICs to appear. Its RASI (RAS input), MSEL (multiplex select), and CASI (CAS input) pins accept timing signals from external circuitry.

Because of its early introduction, the Am2968A has become sufficiently popular to gain two alternate-source vendors: Motorola offers the MC74F2968A and Texas Instruments offers the SN74ALS2968 and a similar part, the SN74ALS2967; the latter has low-true RASI and

CASI signals. These controllers have 9-bit, 2-to-1 address multiplexers, so they accommodate DRAMs having capacities as large as 256k bits. AMD and TI now offer the Am29368 and the SN74ALS6302, respectively. These two controllers closely resemble the original Am2968 design, but they have an extra bit in the address multiplexer, so they support 1M-bit DRAMs. If you prefer low-true RASI and CASI signals, you can choose TI's SN74ALS6301 controller, which fills that bill.

TABLE 1 — REPRESENTATIVE DRAM-CONTROLLER ICs

MANUFACTURER	PART NUMBER	LARGEST RAM TYPE SUPPORTED (BITS)	BANKS	ADDRESS LATCHES	RAS/CAS TIMING
ADVANCED MICRO DEVICES	Am2968A	256k	4	YES	EXTERNAL
	Am29368	1M	4	YES	EXTERNAL
	673102	256k	4	YES	INT/EXT
	673103	1M	4	YES	INT/EXT
	673104	1M	4	YES	INT/EXT
AT&T	WE 32103	1M	4	YES	INTERNAL
HITACHI	HD63487 ²	256k×4 STATIC COLUMN	1	NO	INTERNAL
INTEL	8207	256k	4	YES	INTERNAL
	82C08	256k	2	YES	INTERNAL
MOTOROLA	MC74F2968A	256k	4	YES	EXTERNAL
NATIONAL SEMICONDUCTOR	DP8409	256k	4	YES	INT/EXT
	DP8419	256k	4	YES	INT/EXT
	DP8420	256k	4	YES	INTERNAL
	DP8421	1M	4	YES	INTERNAL
	DP8422	4M	4	YES	INTERNAL
	DP8429	1M	4	YES	INT/EXT
NCR	52C40 ²	4M	4	YES	INTERNAL
SIGNETICS	74F764	256k	1	YES	INTERNAL
	74F765	256k	1	NO	INTERNAL
	74F1764	1M	1	YES	INTERNAL
	74F1765	1M	1	NO	INTERNAL
TEXAS INSTRUMENTS	SN74ACT4503	1M	4	YES	INTERNAL
	SN74ALS2967	256k	4	YES	EXTERNAL
	SN74ALS2968	256k	4	YES	EXTERNAL
	SN74ALS6301	1M	4	YES	EXTERNAL
	SN74ALS6302	1M	4	YES	EXTERNAL
	THCT4502B	256k	4	YES	INTERNAL
VLSI TECHNOLOGY	VL4500A	64k	2	YES	INTERNAL
	VL4502	256k	4	YES	INTERNAL
	VL86C110	1M	2	NO	INTERNAL

NOTES:

1. PRICING FOR INTEL AND AT&T PARTS IS FOR 10-MHz VERSIONS
2. SEE BOX, "SPECIALIZED DRAM CONTROLLERS"

TECHNOLOGY UPDATE

One reason that DRAM controllers without on-chip RAS/CAS timing have remained popular is that they allow you to generate unconventional CAS sequencing. For memory-subsystem designs that employ special DRAM features such as page- or nibble-access modes, your controller circuitry must generate multiple CAS cycles for each RAS cycle. The DRAM controller must be able to change address lines while continuing to assert CAS for static-column mode access. Controllers without on-chip timing circuits

give you a good compromise between function and density when you employ DRAM burst-access sequences. Most DRAM controllers with internal timing generators do not support such burst-access sequences, so if you use the controller in such a design, you must circumvent the internal generators.

Special parts for burst access

When used in conjunction with a burst-access DRAM-controller design, TI's SN74ALS6310 and SN74ALS6311 ICs help you take

advantage of DRAMs' static-column or page-mode access features. The parts employ 14-bit address comparators to determine whether the current access cycle has the same DRAM row address as the preceding cycle. This detection function allows external circuitry to postpone the termination of the preceding RAS cycle and the initiation of an additional CAS cycle, if necessary. Each device costs \$7.20 (1000).

You can create timing signals for DRAM controllers by using a counter IC and some decoding logic, a

ON-CHIP REFRESH SUPPORT	PRICE ¹	SPECIAL DEVICE FEATURES
COUNTERS	\$19 (100)	EXTERNAL CAS TIMING SUPPORTS NIBBLE-MODE ACCESS
COUNTERS	\$30 (100)	EXTERNAL CAS TIMING SUPPORTS NIBBLE-MODE ACCESS
COUNTERS	\$19 (100)	TWO CAS OUTPUTS FOR BYTE ENABLES IN 16-BIT SYSTEMS
COUNTERS	\$29 (100)	TWO CAS OUTPUTS FOR BYTE ENABLES IN 16-BIT SYSTEMS
COUNTERS	\$36 (100)	FOUR CAS OUTPUTS FOR BYTE ENABLES IN 32-BIT SYSTEMS
CONTROLLER	\$50 (1000)	DUAL-PORT ARBITER, SUPPORTS OVERLAP OF MEMORY ACCESS AND MMU TRANSLATION
CAS BEFORE RAS	\$25 (5000)	MEMORY-INTERFACE CHIP FOR COMPANY'S HD63484 ADVANCED CRT CONTROLLER
CONTROLLER	\$28.60 (1000)	CONTROLS COMPANION ERROR-CORRECTION CHIP AND PROVIDES MEMORY SCRUBBING
CONTROLLER	\$13.20 (1000)	POWER-DOWN MODE KEEPS DRAMS REFRESHED
COUNTERS	\$17.55 (100)	EXTERNAL CAS TIMING SUPPORTS NIBBLE-MODE ACCESS
CONTROLLER	\$6 (1000)	INTERNAL OR EXTERNAL REFRESH CONTROL, REQUIRES EXTERNAL REFRESH CLOCK
CONTROLLER	\$11 (1000)	INTERNAL OR EXTERNAL REFRESH CONTROL, REQUIRES EXTERNAL REFRESH CLOCK
CONTROLLER	\$12 (1000)	WAIT-STATE GENERATOR; MEMORY INTERLEAVING; SUPPORTS NIBBLE, PAGE, AND STATIC-COLUMN ACCESS
CONTROLLER	\$15 (1000)	WAIT-STATE GENERATOR; MEMORY INTERLEAVING; SUPPORTS NIBBLE, PAGE, AND STATIC-COLUMN ACCESS
CONTROLLER	\$20 (1000)	DUAL-PORT; WAIT-STATE GENERATOR; MEMORY INTERLEAVING; SUPPORTS NIBBLE, PAGE, AND STATIC-COLUMN ACCESS
CONTROLLER	\$15 (1000)	INTERNAL OR EXTERNAL REFRESH CONTROL, REQUIRES EXTERNAL REFRESH CLOCK
CONTROLLER	\$23.73 (1000)	DUAL-PORT I/O BUFFER CONTROLLER; ADDRESS AND LENGTH COUNTERS ON BOTH PORTS
CONTROLLER	\$9 (1000)	DUAL-PORTED; SUPPORTS EXTERNAL MULTIPLEXING FOR DRAMS LARGER THAN 256k
CONTROLLER	\$9 (1000)	DUAL-PORTED; SUPPORTS EXTERNAL MULTIPLEXING FOR DRAMS LARGER THAN 256k
CONTROLLER	\$11 (1000)	DUAL-PORTED; SUPPORTS EXTERNAL MULTIPLEXING FOR DRAMS LARGER THAN 1M
CONTROLLER	\$11 (1000)	DUAL-PORTED; SUPPORTS EXTERNAL MULTIPLEXING FOR DRAMS LARGER THAN 1M
CONTROLLER	\$15.60 (1000)	INTERNAL OR EXTERNAL REFRESH INITIATION
COUNTERS	\$11.40 (1000)	EXTERNAL CAS TIMING SUPPORTS NIBBLE-MODE ACCESS
COUNTERS	\$11.40 (1000)	EXTERNAL CAS TIMING SUPPORTS NIBBLE-MODE ACCESS
COUNTERS	\$21.60 (1000)	EXTERNAL CAS TIMING SUPPORTS NIBBLE-MODE ACCESS
COUNTERS	\$21.60 (1000)	EXTERNAL CAS TIMING SUPPORTS NIBBLE-MODE ACCESS
CONTROLLER	\$8.40 (1000)	ON-CHIP ARBITRATION BETWEEN READ/WRITE ACCESS AND REFRESH
CONTROLLER	\$4.95 (10,000)	INTERNAL OR EXTERNAL REFRESH INITIATION
CONTROLLER	\$7.84 (10,000)	ON-CHIP ARBITRATION BETWEEN READ/WRITE ACCESS AND REFRESH
CONTROLLER	\$14.12 (10,000)	ON-CHIP MMU, 3-CHANNEL DMA CONTROLLER, PAGE-MODE ACCESS LOGIC

TECHNOLOGY UPDATE

delay line, or a timing-generator PLD. Counters cost very little, but the combination of a counter and decoding circuits may not be able to create the precise timing resolution you seek. Delay lines provide very precise timing signals with a resolution of a few nanoseconds, and they operate asynchronously, which is advantageous for many designs. Delay lines are often expensive, however.

PLDs give you a lot of flexibility to create complex timing sequences. An example of such a PLD is AMD's \$14.75 (100) Am2971A programmable event generator (PEG), an improved version of the company's Am2971, which runs at 100 MHz and can switch any of its 12 outputs at 10-nsec intervals. (The original Am2971 runs at 70 MHz and can only switch output states every other clock cycle.) The Am2971A has an on-chip phase-locked loop, so it can run at a frequency that's a multiple of your system's clock frequency. AMD offers a \$200 adapter and software kit, AmPegasus, that allows you to program the Am2971 and Am2971A on a Data I/O (Redmond, WA) Model 29 programmer.

Don't forget the refresh

Once you have a memory subsystem's RAS/CAS timing worked out, you must accommodate the DRAMs' need for refresh cycles. Because DRAMs store data as charge on

capacitors, each DRAM memory cell must be refreshed periodically. The traditional refresh technique involves a RAS-only cycle, although some DRAMs implement additional schemes. Every RAS address must be exercised within a refresh-time interval specified by the DRAM manufacturer. Failure to refresh the DRAMs allows the stored charge to bleed off the capacitors and produces memory lapses.

Most DRAM controllers incorporate some sort of refresh-support circuitry, because the function is crucial to proper DRAM operation. Simpler DRAM controllers have a counter that maintains the value of the next row address to be refreshed. You must add a refresh timer to help these parts generate refresh cycles. Here again, you can use a counter IC or a PLD to generate the necessary timing. Or you can use a device designed specifically for that purpose, such as TI's SN74ALS6300 refresh timer, which costs \$7.20 (1000).

More advanced DRAM controllers incorporate complete refresh-control circuitry that generates refresh cycles at appropriate intervals and arbitrates among memory-access requests from other system components (the μ P, the DMA controller, etc) and the on-chip refresh timer. On-chip arbitration lets you avoid adding extra circuitry to the memory subsystem's critical timing

path and can reduce the time needed to arbitrate between access and refresh cycles.

For example, National Semiconductor's DP8422, which incorporates both a refresh controller and a refresh arbiter, has an address-strobe-to-CAS delay of 79 nsec. That delay represents the device's critical timing path. The company's DP8429 controller, which does not incorporate a refresh arbiter, has a critical-path RASIN-to-CAS delay of 70 nsec.

Although the DP8429 initially appears to be faster than the DP8422, it's actually not. To make the DP8429 perform memory accesses as quickly as the DP8422, you must make sure that the refresh-arbitration circuitry you place between the DP8429 and your μ P adds no more than 9 nsec of delay to that critical path. Some lower-performance-system designs use the host μ P or a DMA controller to refresh the DRAMs, so they don't need circuitry to arbitrate between access and refresh cycles and they don't require a DRAM controller with a refresh arbiter.

A rest stop for tired DRAMs

Once you've satisfied both the RAS/CAS and the refresh timing, you may also need to ensure that the DRAMs' RAS-precharge requirements are met. The RAS-precharge period allows the DRAMs to rest

Special DRAM controllers suit niche applications

Although most DRAM controllers fall into the general-purpose category, a few companies now offer specialized devices for niche applications. These controllers allow DRAMs to work in designs that previously employed static RAMs (SRAMs). For example, Hitachi's HD63487 Memory Interface and Video Attribute Controller (MIVAC) joins the company's HD63484 advanced CRT controller to as many as four 256k \times 4-bit static-column DRAMs. Thus, five ICs can replace as much as 0.5M bytes of SRAM.

NCR's 52C40 CMOS Memory Array Controller

(CMAC) targets I/O applications that require high-speed, dual-ported buffer memories. The CMAC addresses as many as 16M words of DRAM and supports data-transfer rates to 3M words/sec. Each of the device's two ports incorporates an address register and a transfer-length counter so that address generation can occur entirely on the chip during transfers, without intervention by the host μ P. Because the buffer-memory data path does not flow through the CMAC, you can implement any word width your application requires.

SUPER FAST SRAM

Available Now
256K 25ns / 64K 15ns

Micron just broke the SRAM speed barrier with our family of leading edge, super high speed CMOS SRAMs.

We've applied the same state-of-the-art design and process technology used for our high quality DRAMs in development of our fast static RAMs — with some amazing results.

At an incredible 25ns for 256K and 15ns for 64K, our SRAMs are breaking speed records. And we're not just sampling product, we're shipping production volumes.

Choose from a wide variety of components in DIP, SOJ and LCC packages, with densities from 16K to 256K and organizations of x1, x4 and x8.

And like all Micron memory products, our SRAMs are backed by the type of strong sales, customer service and technical support that keeps you on the leading edge.

For additional information on how you can break the SRAM speed barrier, call 208-386-3900.

Micron, it's a name worth remembering.

Part #	Organization	Speed *	Packages
MT5C2561	256K X 1	25ns	PDIP, CDIP, SOJ, LCC
MT5C2564	64K X 4	25ns	PDIP, CDIP, SOJ, LCC
MT5C2565	64K X 4 $\overline{\text{OE}}$	25ns	PDIP, CDIP, SOJ, LCC
MT5C2568	32K X 8	25ns	PDIP, CDIP, SOJ, LCC
MT5C6401	64K X 1	15ns	PDIP, CDIP, SOJ
MT5C6404	16K X 4	15ns	PDIP, CDIP, SOJ
MT5C6405	16K X 4 $\overline{\text{OE}}$	15ns	PDIP, CDIP, SOJ
MT5C6406/7	16K X 4 s.I/O	15ns	PDIP, CDIP, SOJ
MT5C6408	8K X 8	15ns	PDIP, CDIP, SOJ, LCC
MT5C1601	16K X 1	15ns	PDIP, CDIP, SOJ
MT5C1604	4K X 4	15ns	PDIP, CDIP, SOJ
MT5C1605	4K X 4 $\overline{\text{OE}}$	15ns	PDIP, CDIP, SOJ
MT5C1606/7	4K X 4 s.I/O	15ns	PDIP, CDIP, SOJ
MT5C1608	2K X 8	15ns	PDIP, CDIP, SOJ

*Slower speeds also available.

MICRON

TECHNOLOGY, INC.

MICRON TECHNOLOGY, INC., 2805 E. COLUMBIA ROAD, BOISE, IDAHO 83706 208-386-3900

TECHNOLOGY UPDATE

between access cycles. During RAS precharge, a DRAM recovers from a previous cycle by charging internal nodes to appropriate reference-voltage levels, in preparation for the next cycle. DRAMs require RAS-precharge periods between successive access cycles, following an access and just before a refresh cycle, and just before an access cycle that immediately follows a refresh cycle.

If you fail to comply with a DRAM's RAS-precharge requirements, you invite memory failures. Many μ Ps normally allow ample time between access cycles for RAS precharge, but adding refresh cycles and DMA accesses to the cycle mix can complicate system timings and create RAS-precharge period violations. Multiprocessor-based designs can also encounter RAS-precharge problems.

A DRAM controller that incorporates a RAS-precharge timer and a refresh controller helps you avoid RAS-precharge problems. National Semiconductor's DP8420, DP8421, and DP8422, for example, contain a programmable timer that enforces a delay of 1 to 3 clock cycles between accesses. However, you can add circuitry to less-complex controllers to serve the same purpose. In simpler systems that lack DMA controllers and do not employ multiple processors, you may find that you don't need RAS-precharge timing circuitry, because the system's design inherently precludes such problems.

Two ports may be better than one

Shared-memory, multiprocessor systems place additional burdens on the memory-subsystem designer beyond the need to avoid RAS-precharge violations. Besides the refresh-cycle arbitration circuitry, you need circuitry to arbitrate among multiple access requests. For synchronous systems, arbitration generally doesn't present too much of a problem, but asynchronous arbitration logic introduces one of the worst problems a logic designer can face: metastability.



The data sheets, application notes, and devices packaged in the \$149 Memory Management Design Kit from Texas Instruments constitute a complete memory-subsystem design package. The kit also includes floppy disks containing graphic-symbol libraries from Logic Automation (Beaverton, OR) and FutureNet (Chatsworth, CA); the libraries support the automated design of memory subsystems that use parts from the kit.

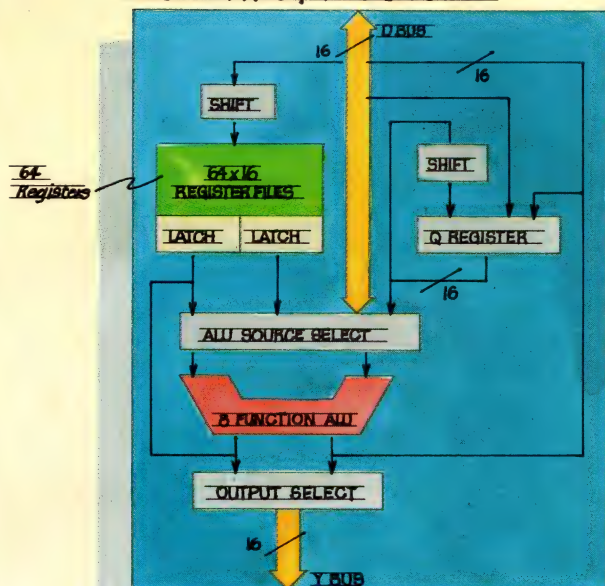
When an arbitration flip-flop enters a metastable state because of setup-and-hold violations, its outputs assume an indeterminate value. In practice, that means that either no requesting processor will be granted access to the memory subsystem, or more than one processor will be granted simultaneous access. Either case generally results in a catastrophic system crash. Asynchronous, multiport arbiters constructed from MSI components

are riddled with metastability problems.

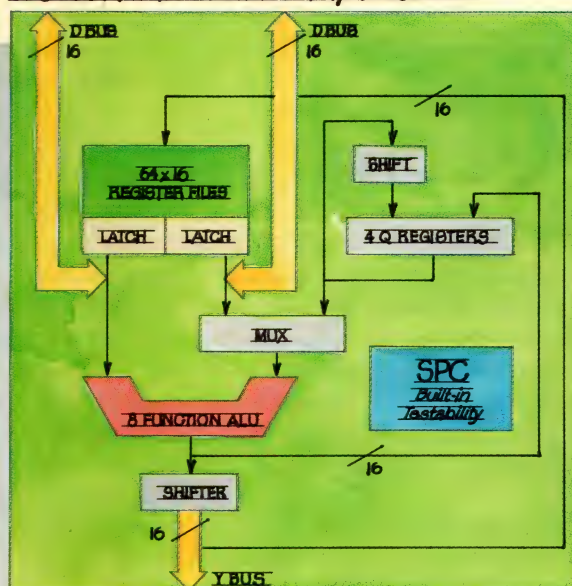
Some DRAM-controller vendors offer dual-ported parts and attack the metastability problem in a variety of ways. National Semiconductor's DP8422 contains synchronous dual-port arbitration circuitry. Your design must meet the part's setup-and-hold requirements. For systems in which the various requesters all run on synchronized clocks, this approach is the simplest solution.

The Ultimate 16-bit slice...

49C402: FAST, TWO BUSES



49C403: HIGH BANDWIDTH, 3 BUSES



It's your choice!

If you need speed, choose the CMOS 2-bus IDT49C402

- Two-bus 2901-type architecture
- Fastest: 37ns RAM address to output
- 10ns set-up—Direct D-bus to RAM and Q
- Independent RAM & Q shifts

64 deep register file. Provides you with more on-chip working space for your high-speed multi-tasking algorithms.

Eight new destination functions. New operands now can be brought into the register file during ALU operations; ideal for address generation.

Now in plastic packages. Low-cost, compact, 68-pin plastic pin grid array and surface mount PLCC.

Upgrade your existing 2901 design. 2901 instruction set compatible so it is easy to upgrade. ☐ Higher performance: 50% faster than 2901C. ☐ Reduced board space: 68 pins vs. 176 pins (5 parts). ☐ Lower power dissipation: 1 watt vs. >5 watts (bipolar).

If you need flexibility and high bandwidth, choose the CMOS 3-bus IDT49C403.

- Three-bus 2903-type architecture
- Fast: 50ns RAM address to output delay
- Expandable register file
- Byte as well as word operations
- SPC™ diagnostics logic

Expandable register file. Can be expanded to provide even more working space for complex digital signal processing algorithms.

Three-bus architecture. For high bus bandwidth. Can perform high-speed integer functions while fixed/floating point multipliers perform the matrix calculations. Ideal for graphics.

On-chip SPC diagnostics. Provides on-chip diagnostic support for design debug, production board level test and field diagnostics.

Upgrade your existing 2903/203 system. 2903/203 instruction set compatible. Performs BCD arithmetic and word and byte operations. ☐ Better performance — 40% faster than 2903A. ☐ Reduced board space — 108 pins vs. 208 pins (5 parts). ☐ Lower power dissipation — 1 watt vs. >5 watts bipolar.

SPC and MICROSLICE are trademarks of Integrated Device Technology
FAST is a trademark of Fairchild Semiconductor Company

The IDT CMOS Microslice™ Solution

Fastest Sequencers—for microinstruction execution control—49C410, 16-bit sequencer and 39C10, 12-bit sequencer (=2910A)

NEW Writable Control Store RAM—for microprogram memory—71502, 4Kx16 Registered RAM

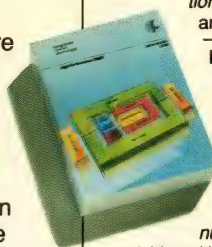
Fastest Register Files—for expanding your 49C403—39C705/7 (=29705/7)

Fastest Multipliers & MACs—for number crunching graphics—7216/7, 16-bit multipliers, 20ns ☐ 721264/5 - 32-/64-bit IEEE floating point multiplier and ALU, 33.4/25 MFLOPS

Fastest Bus Interface Logic—49FCT818, 8-bit Register with SPC ☐ 49FCT618, 16-bit register with SPC ☐ 54/74FCT800B 30% faster than 29800A ☐ 54/74FCTxxxA 30% faster than FAST™

Fastest 4-bit slices—39C01/03/203 = 2901/03/203 ☐ 39C09/11 = 2909/11

Call 408-492-8314 for your free copy of our new 1800 page, 1988 high-performance CMOS DATA BOOK. Or call your local IDT representative.



Integrated Device Technology

3236 Scott Blvd.
Santa Clara, CA 95054-3090
(408) 492-8314
FAX: 408 727-2328



TECHNOLOGY UPDATE

However, not all multiprocessor systems have the luxury of synchronous operation. For example, a system that includes both a standard μ P and a processor built from bit-slice components rarely runs the two dissimilar processors synchronously. Such systems require asynchronous arbiters built from very fast, metastable-hardened flip-flops that have small setup-and-hold-time requirements. Metastable-hardened flip-flops do not eliminate metastability but they can reduce the problem to insignificance. Signetics is one company that has incorporated metastable-hardened flip-flops in its dual-ported DRAM controllers.

The DRAM-controller toolkit

Multiport DRAM controllers represent the first step away from general-purpose parts. If you think your design might benefit from an even more tailored device, consider using TI's DRAM-controller ASIC

toolkit, which lets you employ the company's 1- μ m ASIC process to build custom controllers with as many as four ports. The toolkit includes modules for a fairly sophisticated DRAM controller, for a 4-port arbiter, and for several interfaces to standard μ Ps such as the Motorola 68020 and 68030 and Intel's 80186, 80286, and 80386. The company can assist you in building processor interfaces for other μ Ps as well.

TI defines an ASIC toolkit as a set of supermacros (functional blocks or modules). Its DRAM-controller toolkit works with its TSC500 standard-cell library. The toolkit costs between \$10,000 and \$20,000, depending on the modules you license, and it runs on the Mentor Graphics family of engineering workstations.

The toolkit's DRAM controller contains several programmable or selectable functions, including RAS/CAS timing, latch-and-go circuitry

that allows the host μ P to initiate a write to memory and then immediately proceed to the next bus cycle before the write operation is complete, a row-detection comparator similar to that provided by the company's SN74ALS6310 and SN74ALS6311, and a wait-state generator.

Because of the number of different options available to the controller, the company recommends that you make at least some of the controller's programming signals accessible to external circuitry, either through input pins or via a set of control registers. By adding such programmability, you can create an ASIC that you can incorporate in several different designs. This programmability also allows you to tune the controller's DRAM timing sequences once the ASIC is installed on a pc board. The ability to perform such fine-tuning can be critical when you need to squeeze every

Careful layout optimizes memory performance

The main enemy of precise DRAM timing control is capacitance contained in the pc-board traces and in DRAM address-line inputs. Large capacitive loads slow DRAM-controller performance, a factor you must take into account when calculating the overall performance your memory subsystem will deliver. The amount of capacitance your memory subsystem presents to the controller depends on the number and type of DRAMs you use and on the pc-board layout.

Further, if you add external buffers to help the DRAM controller drive high capacitances, you'll have to account for the buffer delays in your timing calculations. If the controller you select does not have a sufficient number of RAS outputs to drive the DRAM banks your application requires, you'll have to add external multiplexing circuitry. You may also need to add external multiplexers to the DRAM controller's CAS outputs for 16-bit-word, 32-bit-word, and wider memory subsystems that must also support byte-wide transfers. Most DRAM controllers lack multiple CAS drivers. Some other devices that do have more than one CAS output can't use these CAS drivers to perform byte-mode accesses. Multiplexers introduce

additional delay.

Because it's very tough to accurately predict and model these buffer delays, multiplexer delays, and pc-board capacitances before fabricating a pc board and building a prototype memory subsystem, you should design flexibility into the address-sequence timing for a DRAM array. No amount of CAE modeling is going to allow you to build an optimized circuit from the loose characterizations of MSI components and modeled pc-board-trace characteristics. If you use a DRAM controller with internal timing, you'll want to make sure the part allows you to tweak sequence timing. If you use external circuitry for sequencing control, be sure to build some timing leeway into that circuitry.

Line reflections also hamper your ability to accurately model the performance of a memory subsystem. The long traces generally used to wire large DRAM arrays are transmission lines. You must either terminate these lines to prevent reflections or take reflections into account.

If your design employs proper terminations and output buffers capable of driving the line's characteristic impedance, you'll observe incident-wave

TECHNOLOGY UPDATE

unnecessary nanosecond out of the memory's access time.

One module this DRAM controller toolkit does not include is a set of DRAM output drivers. All of the DRAM controllers listed in **Table 1** can drive the high-capacitance loads of large DRAM arrays, but TI's 1- μ m process can't build such husky output circuits. If you use this toolkit to design an ASIC DRAM controller, you should plan to add external buffers to your final circuit. Buffers add additional delay to the DRAM control-signal timing, so access to the controller's programmable timing features will be even more important.

The toolkit's four arbiter ports employ double-latch synchronizers to handle asynchronous access requests. The latches in the synchronizer operate from opposite edges of the controller's 50-MHz clock. TI claims it has thoroughly characterized the metastable characteristics

of flip-flops built with its 1- μ m process and verified that flip-flops entering a metastable state at one edge of the clock will recover in less than 10 nsec—before the next clock edge. Thus, the second synchronizer latch prevents any metastability that might occur in the first latch from confusing the arbiter. This synchronization technique adds a clock delay of between 0.5 and 1 (less than 20 nsec) to a memory subsystem's access time.

Controllers tailored to a μ P

You may not need to resort to an ASIC in order to obtain a specialized DRAM controller. VLSI Technology and AT&T manufacture controllers specifically adapted to μ Ps from those companies. Both companies' parts illustrate ways in which you can closely integrate DRAM-controller functions in a system.

AT&T's WE 32103 DRAM controller is a companion part for the

company's WE 32100 32-bit μ P. Because the controller is intimately mated to the processor, it can boost the memory subsystem's performance beyond the level you might achieve with a general-purpose part. For example, the controller initiates memory cycles early in the processor's bus cycle by emitting an appropriate row address and asserting RAS, but it delays CAS until its chip-select input is asserted. In the event that the current bus cycle is not directed at the DRAM array, the controller terminates the memory cycle without asserting CAS, transforming the operation into an extra refresh cycle.

Likewise, by using low-order, untranslated address bits for the row address, the controller can initiate a memory cycle before the processor's memory-management unit (MMU) translates a logical address to a physical address. This feature allows the controller to overlap MMU

switching in your circuit—in other words, the voltage at the DRAM's input will reach proper logic levels when the incident wave reaches that pin.

However, if your signal lines are unterminated and the output buffers in your design can't drive the line's characteristic impedance, or if you employ a series line termination (limiting the output buffer's drive current), you'll observe reflected-wave switching: The voltage at the DRAM's input will move halfway towards the buffer's output voltage when the incident wave passes it and will match the driver's output voltage after the wave is reflected at the far (unterminated) end of the line. Thus, reflected-wave switching takes somewhat longer than incident-wave switching because signals must propagate over longer paths before switching occurs.

Signetics' DRAM controllers give you a choice between incident-wave switching and reflected switching. The company's 74F764, 74F765, 74F1764, and 74F1765 controllers all incorporate unterminated output drivers, which provide incident-wave switching at the expense of allowing undershoot. Significant voltage undershoot can

wreck DRAM performance, but you can add line terminations to reduce this problem. The company also offers these same four devices with internal terminations at the same price as the unterminated parts. These parts (designated by a -1 suffix on the part number) provide reflected-wave switching and reduce undershoot. Signetics claims that arrays driven by its reflected-wave parts generally need no further termination.

You must also be very careful to provide good grounding and power-supply paths to the DRAM controller, because large DRAM arrays exhibit highly capacitive loads. At times—such as during a refresh cycle—the DRAM controller may try to change the logic levels on all of the address lines in the entire memory array simultaneously. During such events, the current flowing through the DRAM controller's power and ground pins will peak as charge stored in those address lines is dumped. If you don't provide low-impedance paths and adequate bypass capacitance to the ground and power pins, the logic levels inside the chip will shift as the ground rises and V_{CC} droops, causing the controller to behave unpredictably.

TECHNOLOGY UPDATE

and memory-subsystem operation, further improving system performance. The DRAM controller can perform burst-access cycles, which also enhance system performance, on page- and nibble-mode DRAMs for WE 32100 double- and quadruple-word data transfers.

Similarly, VLSI Technology's VL86C110's memory controller is closely coupled to the company's VL86C010 32-bit RISC (reduced instruction set computer) μ P. Acorn Computers Ltd (Cambridge, UK) developed the controller as part of a chip set for a series of low-cost, 32-bit workstations, but VLSI Technology markets the part to other companies as well.

The VL86C110 incorporates several functions not generally found in general-purpose DRAM controllers. For example, the device contains a 3-channel DMA controller, which was originally included in the IC's design to support video, sound, and cursor operations in Acorn's work-

stations. The DRAM controller translates the RISC μ P's ability to signal the occurrence of sequential memory accesses into multiple-CAS access cycles for page-mode DRAMs. The controller also incorporates an MMU that's tailored to the Acorn workstation's memory map and ROM interface circuitry; the MMU accommodates ROMs with access speeds as slow as 450 nsec. Consequently, the VL86C010 contains a clock generator that drives the RISC μ P and allows the controller to stretch the clocks during accesses to slow ROMs.

The diversity and price range of the DRAM controllers listed in **Table 1** demonstrate that no single component can possibly meet the needs of every application. Fortunately, this diversity works to your advantage. If you carefully list your application's needs and prioritize the features you'd like, you'll undoubtedly find a controller that meets your requirements. **EDN**

References

1. *Advanced Peripheral Processing Solutions, Memory Support*, Publication No 400037, National Semiconductor Corp, Santa Clara, CA, 1986.
2. *ASIC DRAM Controller Toolkit*, Preliminary Release, Texas Instruments Inc, Dallas, TX, May 26, 1988.
3. *Memory Management Applications Handbook*, Publication No SDVA002A, Texas Instruments Inc, Dallas, TX, July, 1987.
4. *Memory Management Products Primer*, Publication No SDVA003, Texas Instruments Inc, Dallas, TX, 1987.

Article Interest Quotient
(Circle One)

High 518 Medium 519 Low 520

For more information . . .

For more information on the DRAM-controller ICs mentioned in this article, contact the following manufacturers directly, circle the appropriate numbers on the Information Retrieval Service card, or use EDN's Express Request service.

Advanced Micro Devices

Box 3453
Sunnyvale, CA 94088
(408) 732-2400
TLX 346306
TWX 910-339-9280
Circle No 710

AT&T Technologies

Dept 50AL203140
555 Union Blvd
Allentown, PA 18103
(800) 372-2447
Circle No 711

Hitachi Ltd

Semiconductor & IC Sales & Service Div
2210 O'Toole Ave
San Jose, CA 95131
(408) 435-8300
TLX 171581
TWX 910-338-2103
Circle No 712

Intel Corp

3065 Bowers Ave
Santa Clara, CA 95051
(800) 548-4725
Circle No 713

Motorola Inc

Box 20912
Phoenix, AZ 85036
(800) 521-6274
Circle No 714

National Semiconductor Corp

Box 58090
Santa Clara, CA 95052
(408) 721-5000
TWX 910-339-9240
Circle No 715

NCR Microelectronics Div

1635 Aeroplaza Dr
Colorado Springs, CO 80916
(303) 596-5612
TLX 452457
Circle No 716

Signetics Corp

Box 3409
Sunnyvale, CA 94088
(408) 991-2000
Circle No 717

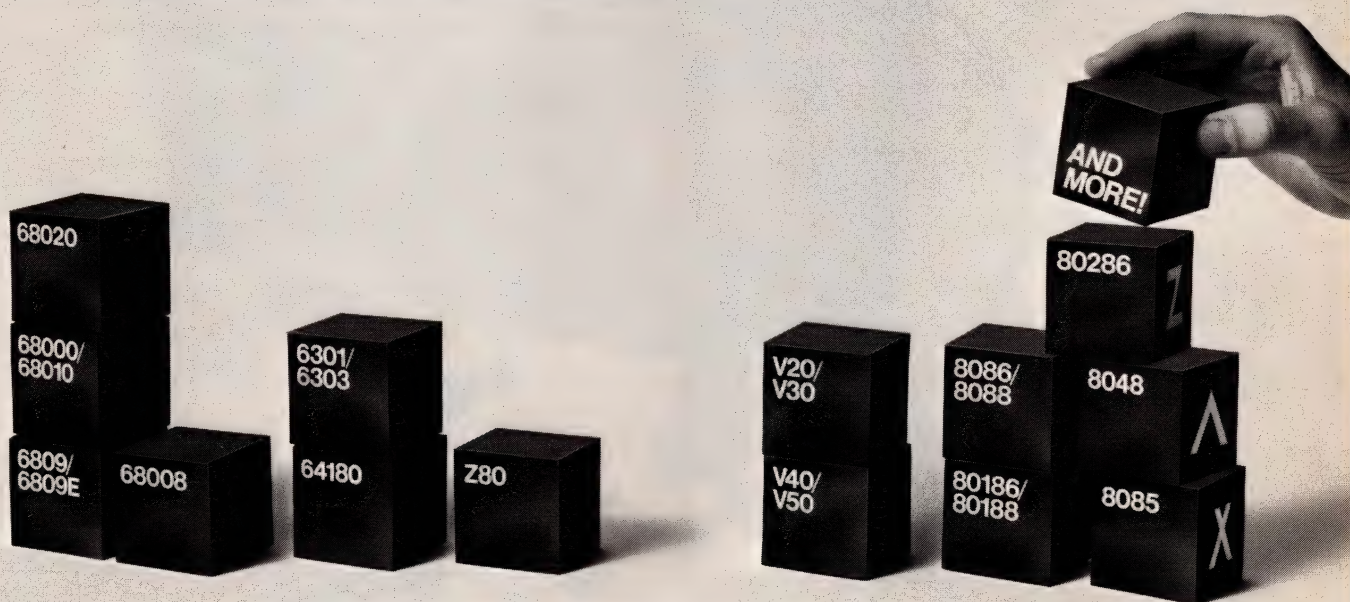
Texas Instruments Inc

Semiconductor Group (SC-780)
Box 809066
Dallas, TX 75380
(800) 232-3200 ext 700
Circle No 718

VLSI Technology Inc

Application Specific Logic Products Div
8375 S River Parkway
Tempe, AZ 85284
(602) 752-8574
Circle No 719

Microprocessor Support Made Simple



Now, ZAX simplifies microprocessor design, integration and testing with their advanced line of ERX- and ICD-series emulators. You simply tell us the processor that drives your design and we tailor a development system especially for your environment, including full software support.

Our ERX-series emulators provide over 80 debugging commands, with 256,000 hardware breakpoints, real-time performance analysis, high-level language debug and trace analysis of program execution while you emulate in real-time. And they interface directly to your personal computer (AT-class) to provide you with a complete host development station and emulation manager. This consolidated approach utilizes industry-standard equipment and eliminates the use of a proprietary dedicated chassis.

ZAX established the benchmark for standalone emulation tools when they introduced their versatile line of ICD-series emulators. Completely flexible, ICD-series emulators can be interfaced to *either a simple terminal or host computer* (from pc to mainframe) depending on your requirements. This makes them ideal for both *in-house development and on-site testing*.

Simplify support for your microprocessor development projects with the help of ZAX! Call today to arrange a product demonstration or write for complete details about our product line. Call us TOLL FREE at 800-421-0982 (in California phone 800-233-9817) or write to ZAX CORPORATION, 2572 White Road, Irvine, CA 92714.

In Europe, call United Kingdom: 0628 476 741, West Germany: 02162-3798-0, France: (03) 956-8142, Italy: (02) 688-2141.



ZAX
Zax Corporation



If you built your own logic analyzer... ...it would be

Why make just an analyzer when you could build a complete, flexible logic analysis system? A modular system with a 400 megasample/s digitizing oscilloscope, an interactive 50 Mbit/s pattern generator, up to 400 state/timing channels available, and a variety of features that make it versatile and easy to use. Plus a configurable price that you could easily justify to the boss.

Fortunately, you don't have to build it yourself to get all this. Just choose the modular HP 16500A Logic Analysis System. HP has already done it for you.

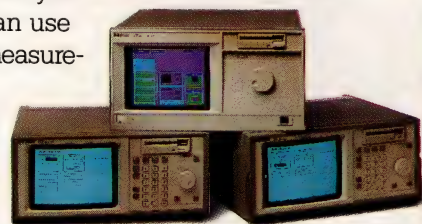
HP Logic Analyzers: the extra measure.

Like all HP logic analysis tools, the HP 16500A delivers an extra measure of value. There are four different measurement modules to choose from. To maximize your investment, configure the HP 16500A, using its five mainframe slots, with the module combination that best matches your budget and application. Just imagine the possibilities for mixing and matching:

- 80-channel, 25MHz state/100MHz transitional timing module (400 channels maximum)
- 2-channel, 400 megasample/s digitizing scope module (8 channels maximum)

- 50 Mbit/s pattern generator module (204 channels maximum)
- 16-channel, 1 GHz timing analyzer module (80 channels maximum)

If your applications are in hardware, powerful inter-module cross-domain triggering allows high speed waveforms from both the scope and analyzer modules to be time correlated, giving you unmatched analysis capability. And you can use measure-



we never stop
asking

"What if..."



more than a logic analyzer.

ment results for simulation by using HP's bi-directional CAE link.

If you're a software developer, the HP 16500A offers complete support for popular 8-, 16- and 32-bit microprocessors. You can also develop your own support package for use with your custom processors or ASICs.

But we didn't stop there. We designed a full set of features into the HP 16500A that make it easy to use. A touch screen or mouse controls functions through pop-up menus. Use your choice of a front panel knob or screen keyboard to change values. Plus, there are two built-in disc drives for data set-up and storage, HP Auto-Scale, EDN August 18, 1988

and color hardcopy output at the push of a button. And the proverbial much more.

Call for your free video!
1-800-752-0900, Ext. H215.

See for yourself how the modular HP 16500A Logic Analysis System is the logic analysis tool you'd design yourself. Like every logic analyzer in the HP family, it delivers *the extra measure* of value you're looking for!





PHILIPS



Taking the lead in VERSATILITY and SPEED!

Philips' new PM 5785 and PM 5786 pulse generators set the pace in speed, versatility and ease of operation.

Fast because they cover virtually any linear and digital requirement with speeds up to 125 MHz/1 ns transition time.

Versatile because they feature dual output channels with a choice of bipolar, positive and negative pulses and a very wide selection of external trigger and gate functions.

And they're **Easy to use** because erroneous time settings are clearly indicated, and a preset burst mode (optional) facilitates testing: memories, shift registers, counters and other digital circuits.

The PM 5786 features continuously variable rise/fall times from 2 ns to 0.1 s while the extra fast PM 5785 has fixed selectable rise/fall times of 1 ns, 1.5 ns or 2 ns (from 700 ps for 20%...80% for ECL).

Product credibility in technology, technique, quality and service also is assured because the PM 5785 and PM 5786 are backed by the resources of one of the world's largest electronics companies.

For further information, call your local supplier:

Austria* (222) 629141, **Belgium** (2) 5256692/94, **Denmark*** (1) 572222, **Finland*** (0) 5257225, **France** (1) 49428080, **Germany** (561) 5010, **Great Britain** (223) 358866, **Ireland** (1) 952501, **Italy*** (39) 3635240/8/9, **Netherlands** (13) 352455, **Norway*** (2) 680200, **Portugal*** (1) 683121, **Spain*** (1) 4042200, **Sweden** (8) 7821800, **Switzerland** (1) 4882211.

*For Philips products only.

For countries not listed, write to: Philips I&E, T&M Department, Building HKF, 5600 MD Eindhoven, The Netherlands.



ADVANCED TECHNOLOGY
MADE TO MEASURE



PHILIPS

Communications and development package links real-time environment to Unix

Combining communications and software development, the Unibridge package links Unix host systems to OS-9-based real-time target systems. The package allows the systems to communicate via the Ethernet LAN protocol and the TCP/IP (Transmission Control Protocol/Internet Protocol). You can use the Unibridge package to develop software on a Unix host, then download OS-9-compatible code to the real-time target.

The software package includes a C-language cross-compiler for the Unix host, communications software for the Unix host and OS-9 target, and a C compiler and a debug package for the OS-9 target. The C cross-compiler outputs executable OS-9 memory modules.

After downloading the modules via the network, you can debug the code at the source or symbolic level with the OS-9-based debugger.

In addition, the implementation of the TCP/IP allows the user to access the entire OS-9 operating system from the Unix host. The software supports remote log-in with the Telnet TCP/IP terminal-emulation application; it also supports file transfers with the TCP/IP file-transfer-program application, thus allowing you to perform debug operations from the Unix host.

After debug, you can deploy the OS-9-based target as a stand-alone system, or you can employ the target as a real-time front end to a Unix-based supervisor system. The downloaded code can access all of

the shareable system modules in OS-9 such as a library of I/O and mathematical routines. In diskless applications, the entire OS-9 operating system, and the C compiler and debugger can be stored in ROM.

The company presently offers the Unibridge package for Sun workstations, Hewlett-Packard Series 300 workstations, and DEC VAX systems. Unibridge for the VAX works with the VMS operating system as well as with DEC's version of Unix. The package costs \$6500.

—Maury Wright

Microware Systems Corp, 1900 NW 114th St, Des Moines, IA 50322. Phone (515) 224-1929. TWX 910-520-2535.

Circle No 707



Unix systems can host real-time software development efforts with the Unibridge software package. The software links target systems based on the OS-9 real-time operating system to Unix-based hosts via Ethernet and TCP/IP.

Unit gang-programs bipolar and MOS PLDs and upgrades to handle EPROMs and μ P

It's been less than a year since the first programmer appeared that could gang-program MOS PLDs—that is, write the same information into more than one IC at a time. Till now, no widely available programmer could gang-program ECL and other bipolar PLDs. The Gangpro-SP changes that situation. It can gang-program both MOS and bipolar PLDs in 20- and 24-pin DIPs, and you can order it in special con-

as it is when programming devices of a single type.

Clearly, the designers of the Gangpro-SP had production applications in mind; the unit is a stand-alone programmer with 512k bits of program RAM expandable to 4M bits—enough to hold eight JEDEC files. You can operate the programmer with a small handheld keypad included in the base price (or you can connect an ASCII terminal to

programming algorithms stored in EEPROMs inside the unit; the vendor distributes library updates on PC-formatted disks.

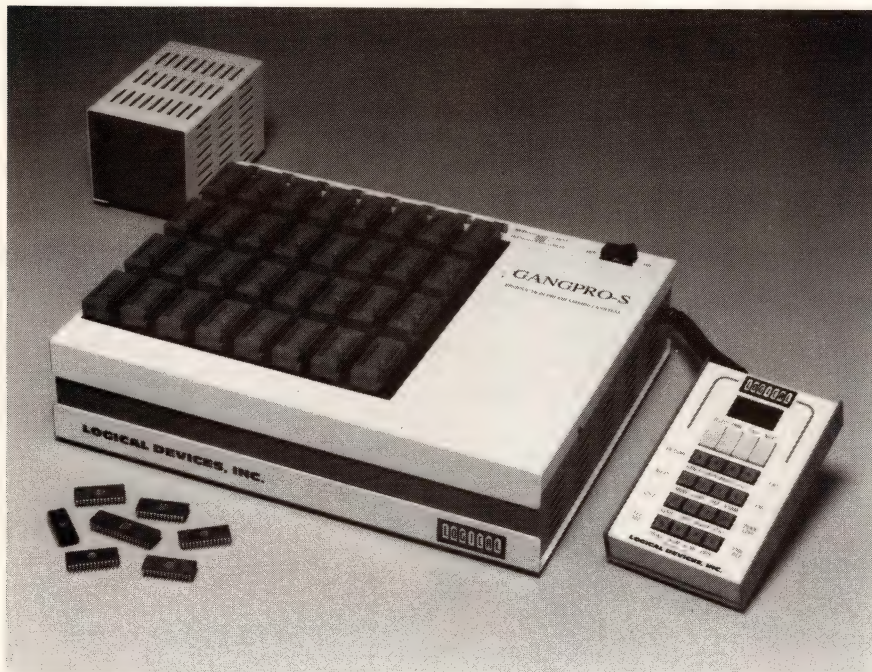
You can upgrade the unit to gang-program EPROMs and some single-chip microprocessors, as well as PLDs. (The configuration that handles 20- and 24-pin DIP PLDs can program eight EPROMs at once; a version that handles *only* EPROMs can program 32 devices simultaneously.) The EPROM/ μ P programming capability gives the instrument broad enough device coverage to make it the only production programmer in many companies. Another feature that should make the programmer popular in production is its internal clock/calendar. It can store the times at which you modify the RAM contents; a label-printing program running on a PC linked to the programmer's serial port can then print out labels that you can place on newly programmed ICs to indicate the exact version of the data they embody.

The Gangpro-SP8 (with eight 20- and 24-pin PLD programming stations) sells for \$7995. The EPROM- μ P upgrade costs \$600/station.

—Dan Strassberg

Logical Devices Inc, 1201 NW 65th Pl, Fort Lauderdale, FL 33309. Phone (800) 331-7766; in FL, (305) 974-0975. TLX 383142.

Circle No 703

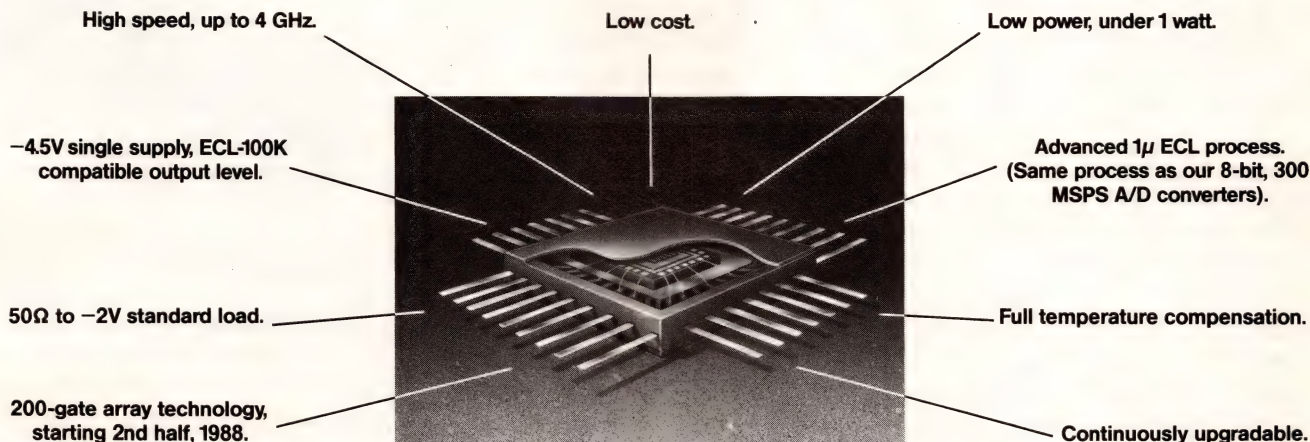


This stand-alone programmer can program 32 EPROMs. When configured to program 20- and 24-pin PLDs (and optionally, EPROMs and μ Ps,) it has eight programming stations.

figurations that handle plastic leaded-chip carriers and pin-grid packages with as many as 68 pins. It can do PLD set programming as well—that is, write *different* data into each of the ICs plugged into it. In fact, the instrument can actually program device sets composed of several types of ICs, though when operating in this mode it isn't as fast

the RS-232C port). You can make the RAM nonvolatile by installing a battery backup option. The keypad-controlled configuration should appeal to departments that can't justify dedicating a PC or terminal to a programmer and have trouble allocating shared resources. The only time you need to connect a PC is when you update the library of pro-

SONY'S ECL LOGIC HAS THE GUTS TO CHALLENGE GAAs PERFORMANCE.



SONY'S HIGH-SPEED ECL LOGIC FAMILY

Part Number	Function	t _{pd}	f _{max}	Power	Package
CXB1100Q	Quad 3-in OR/NOR	390 ps	1.5 GHz	530 mW	24 FLAT
CXB1101Q	Quad 3-in AND/NAND	470 ps	1.5 GHz	700 mW	24 FLAT
CXB1102Q	Quad 2-in EXOR/NOR	490 ps	1.5 GHz	680 mW	24 FLAT
CXB1103Q	Quint Line Receiver	410 ps	1.5 GHz	650 mW	24 FLAT
CXB1104Q	Dual D Flip Flop	620 ps	3.2 GHz	520 mW	24 FLAT
CXB1105Q	Triple Fan-out Buffer	590 ps	1.5 GHz	720 mW	24 FLAT
CXB1106Q	4-Stage Ripple Counter		3.4 GHz	720 mW	24 FLAT
CXB1107Q	Decision Circuit		3.2 GHz	430 mW	24 FLAT
CXB1108Q	Laser Driver		2.0 GHz	740 mW	16 FLAT
CXB1109Q	Quad D-FF with Master Reset	620 ps	3.4 GHz	790 mW	24 FLAT
CXB1110Q	16 to 1 Multiplexer	610 ps	1.5 GHz	680 mW	24 FLAT
CXB1111Q	Look Ahead Carry Block	580 ps	1.5 GHz	610 mW	24 FLAT
CXB1112Q	Phase Frequency Detector	720 ps	0.8 GHz	500 mW	24 FLAT
CXB1113Q	4 to 1 Multiplexer		2.0 GHz	950 mW	24 FLAT
CXB1114Q	1 to 4 Demultiplexer		2.5 GHz	1100 mW	24 FLAT
CXB1130Q	9, 8, 4-bit Multiplexer		1.6 GHz	730 mW	32 FLAT
CXB1131Q	9, 8, 4-bit Demultiplexer		1.6 GHz	1000 mW	32 FLAT
CXB1132Q	9, 8, 4-bit Universal Shift Register		1.3 GHz	910 mW	32 FLAT
CXB1133Q	22, 15, 7-Stage Scrambler		1.6 GHz	600 mW	24 FLAT
CXB1134Q	22, 15, 7-Stage Descrambler		1.6 GHz	610 mW	24 FLAT
CXB1135Q	8-16 bit Comparator		1.3 GHz	630 mW	32 FLAT
CXB1136Q	8-bit Universal Counter		1.2 GHz	730 mW	32 FLAT
CXB1137Q	8-bit Shift Matrix	1250 ps		700 mW	24 FLAT
CXB1138Q	4-bit Arithmetic Logic Unit	1460 ps		680 mW	24 FLAT

When you need high-speed logic, it really pays to look into Sony's ECL logic family.

Because like GaAs technology, you'll find incredibly fast process speeds. Up to 4 GHz.

But unlike GaAs technology, you'll also find amazingly low costs and design simplicity.

Not to mention that our ECL technology, unlike most, requires very low power. Under 1 watt, in many cases.

Sony's ECL logic family is made possible by our unique 1-micron, 10-GHz, FT process. The very process that's made our high-speed, 8-bit, 300 MSPS, A/D converters so popular.

And via our 200-gate array technology, we offer a limitless range of logic functions. Many available in 24 and 32-lead flat

packs. The list you see here is only partial. So if you don't see what you need, please inquire with your specific requirements.

Sony's ECL logic family is available now, backed by the quality, reliability and nationwide service you expect from any Sony product.

So get all the information on our high-speed ECL logic family today. Because when it comes to high-speed logic performance, Sony's got the guts to deliver.

Just call the Sony representative nearest you, or call (714) 229-4192. Or write Sony Corporation of America, Component Products Division, 10833 Valley View Street, Cypress, CA 90630. FAX (714) 229-4271.

SONY®

AL Huntsville (205) 533-1730
Mobile (205) 478-1036
AZ Phoenix (602) 257-9015
CA Los Angeles (714) 855-0233
San Diego (619) 729-9216
San Francisco (415) 960-3880

CO Aurora (303) 695-8903
FL (214) 234-8438
GA Norcross (404) 449-8680
IA Cedar Rapids (319) 393-2232
IL Chicago (312) 382-3001
Carmel (317) 844-5222
IN Ft. Wayne (219) 486-1912

MD Randallstown (301) 655-2265
MA Boston (617) 894-8400
MI Livonia (313) 844-5222
MN Eden Prairie (612) 944-7274
MO Bridgeton (314) 291-4230
Raytown (816) 358-8100

NJ Mt. Laurel (609) 866-1234
NM Albuquerque (505) 345-3591
NY Jamaica (718) 291-3232
Syracuse (315) 699-2671
NC Durham (919) 544-6630
Huntersville (704) 892-1366
OH Cincinnati (513) 385-1105

Cleveland (216) 261-9705
OK Tulsa (918) 744-9964
OR Tigard (503) 620-3280
PA Pittsburgh (513) 385-1105
TN Greenville (615) 639-3491
TX Austin (512) 346-9186
Dallas (214) 234-8438

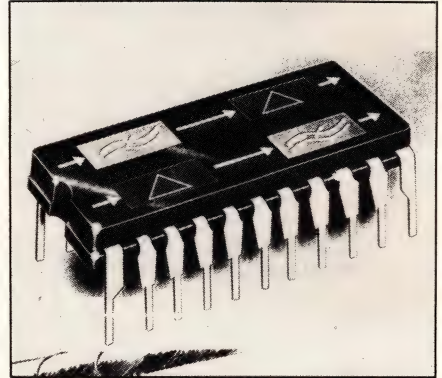
Houston (713) 782-4144
UT Salt Lake City (801) 264-8050
VA Sterling (703) 478-2480
WA Bellevue (206) 455-3460
Spokane (509) 924-4410
WI Waukesha (414) 542-5352

Delta codec meets requirements for military communications

Meeting the requirements of the NATO Eurocom D1-IA8 specification, the FX619 full-duplex, single-chip CVSD (continuously variable slope delta) codec is suitable for use in a variety of military communications systems including delta multiplexers, switches, and telephones. Because it includes both encoder and decoder sections, as well as the audio filters that are required on the encoder input and decoder output, the device can significantly reduce component count, particularly on multichannel line cards. All you need to add are input and output buffers to convert the unbalanced input and output of the FX619 to

the balanced 600 Ω input and output required by the Eurocom spec. Fabricated in CMOS, the device operates from a single 5V supply and draws a typical supply current of 4.5 mA in its active mode, and 500 μ A in its standby mode.

You can program the delta codec's sampling rate to 16k, 32k, or 64k bps, with all timing for the device's switched-capacitor filters and CVSD modulator and demodulator derived from an on-chip oscillator that accepts a 1.024-MHz crystal. Or, you can clock the device from an external clock source to achieve sampling rates within the range of 8k to 64k bps. The device provides



Incorporating input and output filters, as well as a full-duplex delta codec, the FX619 can reduce parts counts in military communications equipment.

clock outputs that allow you to synchronize external circuitry to the codec.

For multiplexer applications, an enable input allows you to enable or disable the encoder section of the device. Other features include an encoder forced-idle mode that generates a 10101010-output bit stream, and a decoder forced-idle mode that produces an output bias of half the supply voltage. You can also program the device to perform either a 3- or 4-bit companding algorithm.

The FX619 is available in a 22-pin ceramic DIP or a 28-lead ceramic surface-mount package. It has an operating temperature range of -40 to $+85^{\circ}\text{C}$ and is processed to MIL-STD-883C requirements. It sells for £20 (1000).— **Peter Harold**

Consumer Microcircuits Ltd, 1 Wheaton Road, Witham, Essex CM8 3TD, UK. Phone (0376) 513833. TLX 99382.

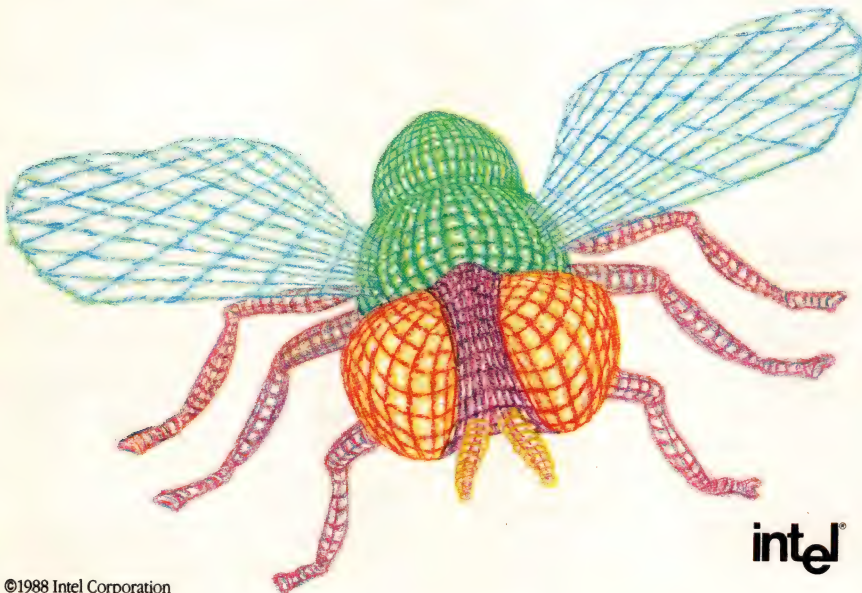
Circle No 701

Mx-Com Inc, 4800 Bethania Station Rd, Winston-Salem, NC 27105. Phone (919) 744-5050.

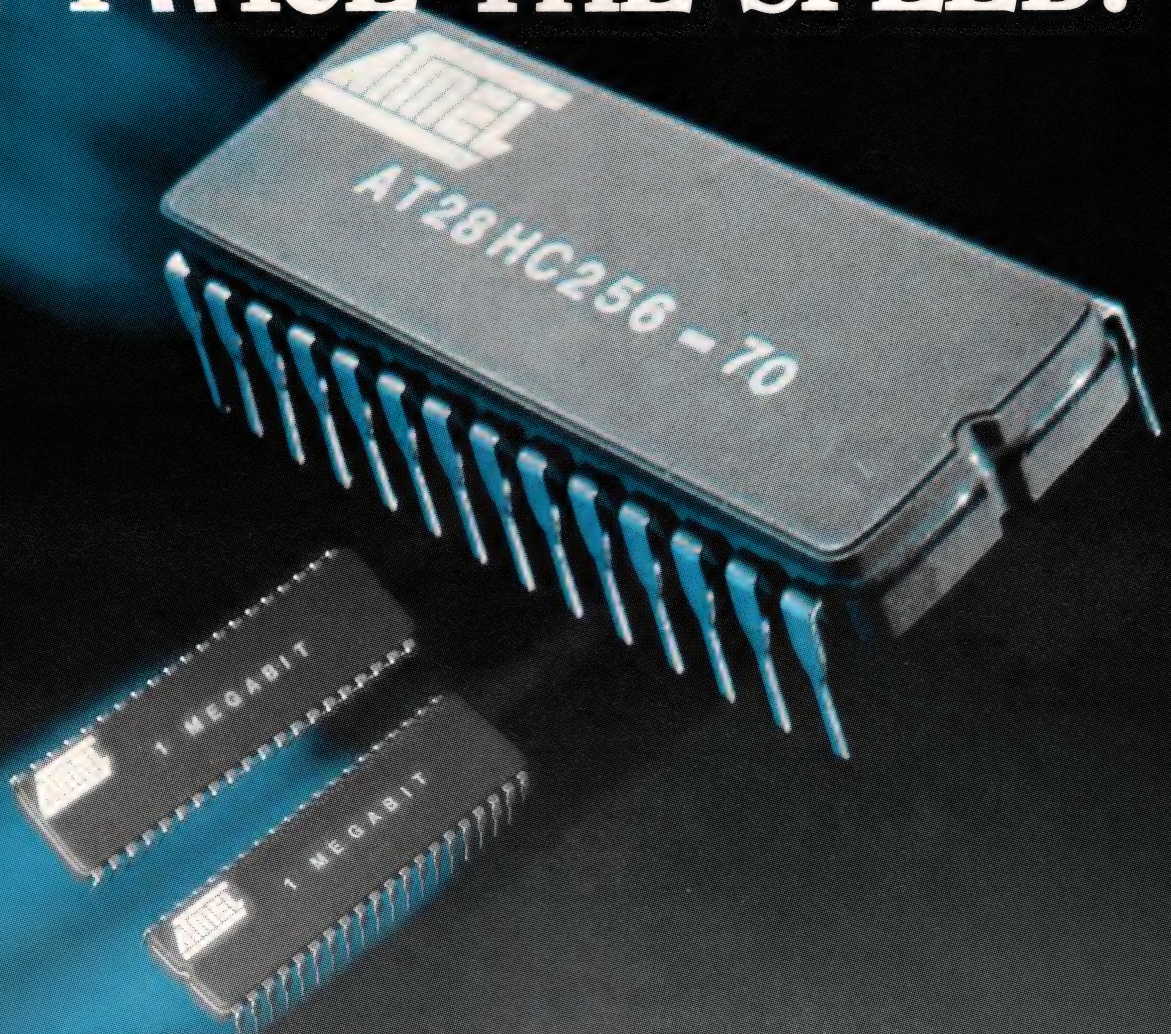
Circle No 702

INTEL EMBEDDED CONTROLLERS DRAW FLIES.

Now your graphics engine can transform 80,000 vectors per second with a single chip. If it's designed with a member of Intel's 80960 family. Just call 800-548-4725 (Lit. Dept. 437).



RELIABILITY AT TWICE THE SPEED.



ATMEL THE CMOS E²PROM LEADER.

Get unmatched reliability, speed and density in the low power AT28C256 and AT28HC256 CMOS E²PROMs.

These 32K x 8 bit devices offer access times as fast as 70ns. That's twice the speed offered by other manufacturers!

Using a proprietary 1.25 μ CMOS technology with unique error correction and software data protection, ATMEL's 256K E²PROMs provide high performance and fault free operation.

ATMEL's 256K E²PROMs also feature:

- Fast 64-byte page write time of 3ms
- DATA Polling
- Software data protection
- Internal error correction
- Chip clear
- Endurance of 10,000 and 100,000 cycles
- 10 year data retention
- 4.5V to 5.5V operation from -55°C to 125°C
- Mil Std 883C compliant

Our 256K E²PROMs are available today, with 1 Megabit devices coming soon.

Make **RELIABILITY** a **REALITY** with ATMEL, the leading supplier of CMOS E²PROMs.

For more information, call (408) 434-9201, FAX (408) 434-9825. Or write 2095 Ringwood Avenue, San Jose, CA 95131.

256K CMOS E²PROM Family

Density	Part Number	Organization	Speed (ns)											Package P D L J F	Mil 883C
			70	90	120	150	200	250	300	350					
256K	AT28C256	32K x 8												• • • • •	•
256K	AT28HC256	32K x 8	•	•	•									• • • • •	•

P-Plastic; D-Ceramic Dip; L-Leadless Ceramic; J-Plastic j-leaded; F-Flat Pack

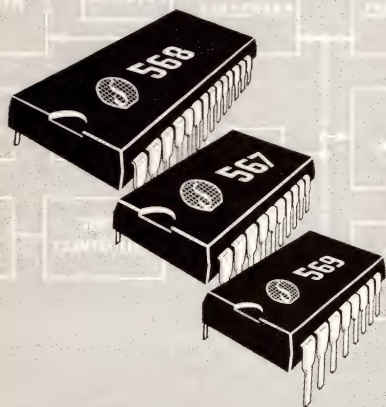


CIRCLE NO 80

Spotlight #25

IN A SERIES

NEW SERVO CHIP SET FOR HIGH PERFORMANCE HARD DISK DRIVES



FEATURES:

SSI 567 SERVO DEMODULATOR

- Servo demodulation for dedicated surface servo systems
- Di-bit quadrature servo pattern
- PLL synchronization

SSI 568 SERVO CONTROLLER

- Servo control for dedicated surface servo systems
- Quadrature servo pattern
- Linear velocity control loop
- Programmable offset and gain control
- Microprocessor bus compatible interface

SSI 569 SERVO MOTOR DRIVER

- Voice coil servo motor predriver
- Compatible with complementary power FETS
- Bridge output driver configuration
- Automatic head retract and spindle motor brake command in the event of power supply failure

Now, with Silicon Systems new Servo Chip Set, HDD designers have the means to provide fast, precise, head positioning in their high performance hard disk drives.

The new chip set provides superior performance and features lower power dissipation, reduced board space, and lower cost than alternative design approaches. With its high level of integration, the set includes all the functional building blocks needed in the servo channel, and it is easily controlled via the microprocessor interface.

For more information, contact:
Silicon Systems, 14351 Myford Road,
Tustin, CA 92680.
Phone: (714) 731-7110, Ext. 575.

silicon systems
INNOVATORS IN INTEGRATION

CIRCLE NO 84

PRODUCT UPDATE

DSO 400M - sample/sec stores 50k-word records

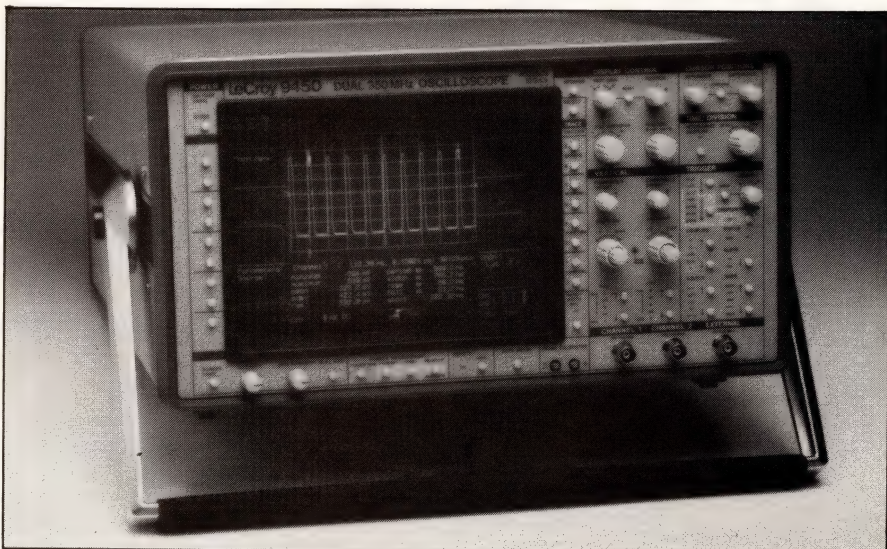
A DSO (digital-storage oscilloscope) whose maximum sampling rate is the same as the LeCroy 9450's—400M samples/sec—but whose maximum record length is a fairly standard 1k words can sample at its maximum rate only at sweep speeds faster than 250 nsec/div. The 9450 is different. Using flash ADCs, it can sample two channels simultaneously to 8-bit precision at 400M samples/sec, and it can do so with its sweep speed set from 1 nsec to $>10 \mu\text{sec/div}$. It owes this unusual ability to acquisition memories that, with 50k words of battery-backed RAM for each of the scope's two channels, are approximately 50 times as deep as those of most competitive scopes. Each memory can store a single waveform record, or you can partition it to store as many as 200 records.

The 9450 is neither the least nor the most expensive high-performance DSO on the market today, but the array of features it offers in

addition to its unusual memory depth clearly make it worth a careful look by anyone considering the purchase of a DSO with fast real-time-sampling capability. People who take a close look are bound to be impressed by the clarity of the 4096×4096 -pixel display on the 5×7 -in., amber-phosphor CRT and the scope's ability to expand a portion of a waveform for close inspection—as much as 1000 times horizontally or 10 times vertically.

A noteworthy feature of the display is the way it portrays waveforms. To avoid an effect known as "perceptual aliasing" the scope draws straight lines between sampled data points. But to avoid confusing you about where the data was actually sampled, it highlights the sampling points.

Like many DSO manufacturers, LeCroy has taken considerable care to provide its scopes with a human interface that mimics those of analog scopes. The 9450, of course, aug-



A 5×7 -in. amber-phosphor CRT and controls that look and feel familiar to analog-scope users hide a number of unusual features of this 400M-sample/sec DSO. For example, two 50k-word display memories allow you to use the maximum sampling rate with relatively long-duration sweeps.

IF YOU'RE DESIGNING DISK DRIVES AND HAVE ONLY USED OUR READ/WRITE CIRCUITS- THIS CHART IS FOR YOU.

Our Extended Family

If you're designing disk drives, you're probably already familiar with Silicon Systems. Chances are good that you are presently using one or more of Silicon Systems' Read/Write amplifier IC's in your HDD designs. But maybe you don't know that we also offer the industry's most extensive line of mass storage ASIC's.

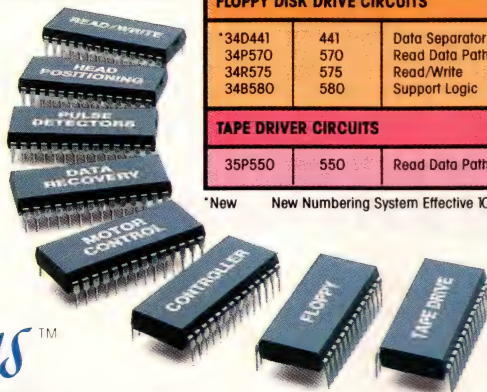
The adjacent chart illustrates that Silicon Systems can also provide more than a score of circuits for pulse detection, data recovery, head positioning, spindle motor control, and controller electronics. And the list continues to grow.

The Mix-and-Match Design Approach

With Silicon Systems growing families of IC's for all the electronic functions in hard disk drives, many leading HDD designers are finding they can now easily mix-and-match SSI products to implement their specific design features. This powerful design approach allows them to reduce board area, eliminate external passives, and lower costs by simplifying their designs.

Call Now!
(714) 731-7110, Ext. 575

For more information,
send for our Disk Drive
mailers. **Silicon Systems**,
14351 Myford Road,
Tustin, CA 92680.



silicon systemsTM
INNOVATORS IN INTEGRATION

"Where we design to your applications."

MICROPERIPHERAL IC SELECTION CHART

SSI Device Numbers		Head Type	# of Channels	Max Input Noise nV/√Hz	Max Input Capacitance (pF)	Read Gain (typ)	Write Current Range (mA)	Power Supplies	Read/Write Data Port(s)
New	Old								
HDD READ/WRITE AMPLIFIERS									
32R104B	104	Ferrite	4	2.4	23	35	15 to 45	+6V, -4V	Differential, Bi-directional
32R104BLN	104L	Ferrite	4	1.7	23	35	15 to 45	+6V, -4V	Differential, Bi-directional
32R114	114	Thin Film	4	1.1	65	123	55 to 110	±5V	Differential/Differential
32R115	115	Ferrite	2, 4, 5	1.8	20	40	30 to 50	±5V	Differential, Bi-directional
32R117	117	Ferrite	2, 4, 6	2.1	23	100	10 to 50	+5V, +12V	Differential/TTL
32R117A	117A	Ferrite	2, 4, 6	1.7	20	100	10 to 50	+5V, +12V	Differential/TTL
32R188	188	Ferrite	4	2.4	18	43	35 to 70	+6V, -5V	Differential, Bi-directional
32R501	501	Ferrite	4, 6, 8	1.5	23	100	10 to 50	+5V, +12V	Differential/TTL
32R510A	510A	Ferrite	2, 4, 6	1.5	20	100	10 to 40	+5V, +12V	Differential/TTL
32R511	511	Ferrite	4, 6, 8	1.5	20	100	10 to 40	+5V, +12V	Differential/TTL
32R512	512	Thin Film	8	0.9	32	150	10 to 40	+5V, +12V	Differential/TTL
32R514	514	Ferrite	2, 4, 6	1.5	20	150	10 to 40	+5V, +12V	Differential/TTL
32R520	520	Thin Film	4	0.9	65	123	30 to 75	±5V	Differential/Differential
32R521	521	Thin Film	6	0.9	65	100	20 to 70	+5V, +12V	Differential/TTL
32R522	522	Thin Film	4, 6	1.0	32	100	6 to 35	+5V, +12V	Differential/TTL
SSI Device Numbers		Circuit Function	Features						
New	Old								
HDD PULSE DETECTION									
32P540	540	Read Data Processor	Time Domain Filter						
32P541	541	Read Data Processor	AGC, Amplitude & Time Pulse Qualification, RLL Compatible						
HDD DATA RECOVERY									
32D531	531	Data Synchronizer	Data Synchronizer/Write Precompensation						
32D532	532	Data Separator	Data Synchronizer/2, 7 RLL ENDEC						
32D533	533	Data Synchronizer	Data Synchronizer/Write Precompensation						
32D534	534	Data Separator	Data Synchronizer/MFM ENDEC/Write Precompensation						
32D535	535	Data Separator	Data Synchronizer/2, 7 RLL ENDEC/Write Precompensation						
HDD HEAD POSITIONING									
32H101A	101A	Preamplifier-Ferrite Head	AV = 93, BW = 10MHz, e _n = 7.0nV/√Hz						
32H116	116	Preamplifier-Thin Film Head	AV = 250, BW = 20MHz, e _n = 0.94nV/√Hz						
32H567	567	Servo Demodulator	Di-bit Quadrature Servo Pattern: PLL Synchronization						
32H568	568	Servo Controller	Track & Seek Mode Operation; Microprocessor Interface						
32H569	569	Servo Motor Driver	Head Parking, Spindle Motor Braking						
HDD SPINDLE MOTOR CONTROL									
32M590	590	2-Phase Motor Speed Control	±0.035% Speed Accuracy; Unipolar Operation						
32M591	591	3-Phase Motor Speed Control	±0.05% Speed Accuracy; Unipolar Operation						
32M593	593	3-Phase Motor Speed Control	±0.037% Speed Accuracy; Bipolar Operation						
HDD CONTROLLER/INTERFACE									
32B450A	450A	SCSI Controller	Async transfer to 2MBPS; Initiate/Target Modes; Internal Drivers; CMOS						
32C452	452	Storage Controller	20Mbits/sec; CMOS; Programmable; AIC-010 Compatible						
32C453	453	Buffer Controller	Non-mux addressing to 16K; CMOS; AIC-300 Compatible						
32B545	545	Support Logic	Includes ST506 Bus Drivers/Receivers						
FLOPPY DISK DRIVE CIRCUITS									
34D441	441	Data Separator	High Performance Analog Data Separator, NEC 765 Compatible						
34P570	570	Read Data Path	2 Channel Read/Write With Read Data Path						
34R575	575	Read/Write	2, 4 Channel Read/Write Circuit						
34B580	580	Support Logic	Port Expander, Includes SA400 Interface Drivers/Receivers						
TAPE DRIVER CIRCUITS									
35P550	550	Read Data Path	4 Channel Read/Write With Read Data Path						

*New New Numbering System Effective 10/1/87

LabVIEW Instrumentation Software.

Our Users Tell the Story.

EDUCATION

University of Southwestern
Louisiana

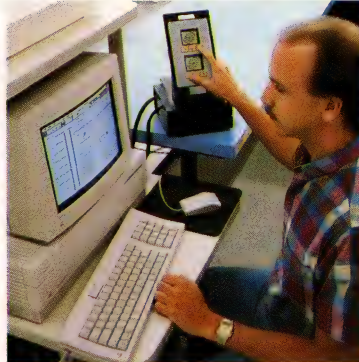
"LabVIEW is the best single software entity that has been written to date for any computer for any purpose." Dr. John O'Dell, professor of Mechanical Engineering, uses LabVIEW in his course on computer-controlled systems.



AUTOMATED TESTING

Sundstrand-Sauer

"With LabVIEW, I have reduced testing time for our control panels from 15 minutes to less than 1 minute." Jay Herman is in charge of testing Sundstrand control panels used on concrete paving machines. A GPIB-controlled power supply tests the power requirements for these machines. Analog and digital lines on the control panel are tested with the NB-MIO-16 board.



MEDICINE

Sahlgren University Hospital-Sweden

"Without any earlier experience with programming, we were writing our own applications after the LabVIEW 3-day training course." Dr. Anders Ullman uses LabVIEW in clinical pharmacology. Muscle contractions evoked by nerve stimulation or by different drugs are measured via isometric force transducers with a plug-in analog input board. Each channel is monitored on a LabVIEW strip chart.



PHYSICS

The University of Texas
at Austin

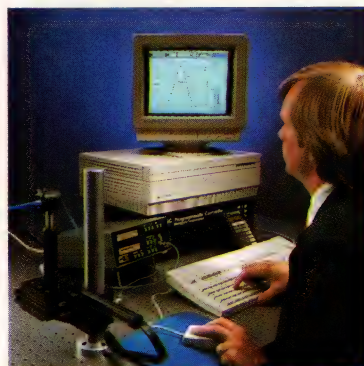
"We initially set up our system on a MicroVAX. It took 6 months. With LabVIEW and a Macintosh II, we got it working in a couple of weeks." Azucena Overman, graduate student in the Physics Department, researches the chemical properties of surfaces. In her research, LabVIEW controls GPIB instruments and graphs the data collected.



OPTICS

Newport Corporation

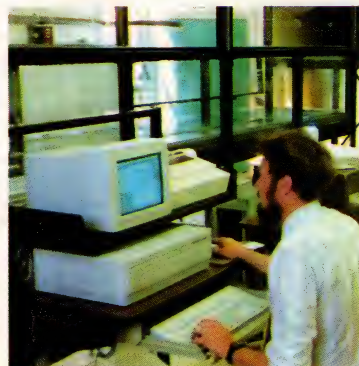
"LabVIEW is the software system we needed to complement our instruments." Scott Jordan includes LabVIEW with a Newport Optical Power Meter and a Newport Programmable Controller in a laser control system marketed by Newport Corporation.



CIVIL ENGINEERING

Stanford University

"LabVIEW is the most flexible data acquisition software I've ever seen—it's also a bit of fun." Dr. Steven Monismith of the Civil Engineering Department uses an experimental pond to research double diffusive systems. LabVIEW and an NB-MIO-16 board measure signals from temperature and conductivity probes in the pond, and control a motor that varies the depth of the probes.



SEMICONDUCTOR RESEARCH

Raytheon Company

"LabVIEW is the system of choice for data acquisition." John Day uses LabVIEW and GPIB instruments to measure physical properties of GaAs semiconductors. LabVIEW generates graphs of capacitance versus frequency and capacitance versus voltage.

Now . . . LabVIEW® 2.0

Faster, more versatile, and even easier to use.

*Graphical Instrumentation Software
for Data Acquisition, Analysis, and Presentation.*



12109 Technology Blvd. Austin, Texas 78727-6204
512/250-9119 800/531-4742 800/IEEE-488 in Texas

SIMULATION

Engineering Measurements Company

"LabVIEW saved me several months of development." John Wacers simulates digital signal processing algorithms with LabVIEW. The algorithms are burned into EPROMs on intelligent flow meters manufactured by Engineering Measurements Company.

National Instruments of Japan 81 (03) 788-1922 • National Instruments of France 1 (48) 65 33 70 • National Instruments United Kingdom 44-01-549-3444 • ARGENTINA 541/46-5776/0628 • AUSTRALIA 61 (3) 879-2322 • BELGIUM 02/735.21.35 • CANADA 416/890-2010 • 613/596-9300 • (514) 747-7878 • 403/295-0822 • (604) 988-2195 • CHILE 56 2253689 • DENMARK 45 02-251122 • FINLAND 358 90-372 144 • FRANCE 33 (1) 69077802 • HONG KONG 852 0-262707 • 852 0-262945 • IRELAND 353 042 72282 • ISRAEL 972 324298 • ITALY 39-2-98491071-2-3 • KOREA (02) 776-3800 • THE NETHERLANDS 31 070-996360 • NEW ZEALAND 64 09 444-2645 • NORWAY 02-531250 • PORTUGAL 19545313 • SINGAPORE 65 29 11336 • SOUTH AFRICA 27 (011) 787-0473 • SPAIN 34 (1) 455 81 12 • SWEDEN 46 08-792 11 00 • SWITZERLAND 41 65 52 8949 • TAIWAN/THE REPUBLIC OF CHINA 886 (02) 7036280 • THAILAND 66 2349330 • UNITED KINGDOM 44 273 608 331 • WEST GERMANY 49 89 807081

UPDATE

ments that interface with on-screen menus and "soft" keys adjacent to its screen. In addition, automated measurement modes abound. For example, the scope can automatically set its sensitivity, sweep speed, and sweep delay to provide a clear picture of a low-repetition-rate pulse. Then, without your having to take additional action, it can provide a numeric display of as many as ten parameters of the pulse train—for example, repetition rate, 10-to-90% rise time, and RMS voltage.

LeCroy boasts about the 9450's flexible triggering: Not only can it delay starting a sweep for a selectable interval following a trigger condition, but it can also delay the sweep until it has recognized a selected number of trigger events—the number can be as large as a billion. A glitch-capture feature lets you trigger on pulses either narrower or wider than a selected duration, and the duration can be as small as 2.5 nsec. Several pattern-triggering modes let you set the scope to trigger only after specified data patterns appear at the two signal inputs, the trigger input, or some combination of the three.

In addition to real-time sampling of periodic or nonperiodic waveforms, the 9450 can also perform random equivalent-time sampling of periodic signals. It can do so at an effective rate of 10G samples/sec. When performing equivalent-time sampling, the scope's frequency response is governed by the 350-MHz bandwidth of its input channels, not by the sampling rate.

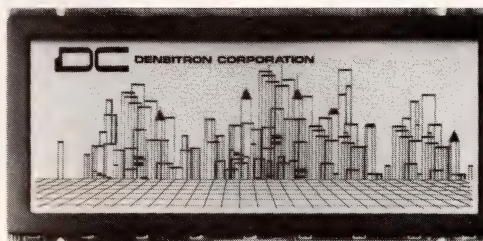
The 9450 includes RS-232C and IEEE-488 ports. You can power it from 110 or 220V ac from 48 to 440 Hz. It weighs 33 lbs and has a list price of \$18,900. Delivery is four to eight weeks ARO.

—**Dan Strassberg**

LeCroy, 700 Chestnut Ridge Rd, Chestnut Ridge, NY 10977. Phone (914) 425-2000. TWX 710-577-2832.

Circle No 705

LCD readability taken to new heights!



- Fluorescent backlighting and Supertwist technology combine to create the brightest and most dynamic graphic liquid crystal display available today.
- Long life 20,000-hr. fluorescent tube emits a bright, even light.
- Supertwist LCD produces a high contrast display with a wide viewing angle.
- Available in 3 sizes: 400x640, 200x640 and 128x256.
- Available in positive or negative images with white, yellow or blue background.

- Thin package with CMOS drivers.
- Controller cards available.

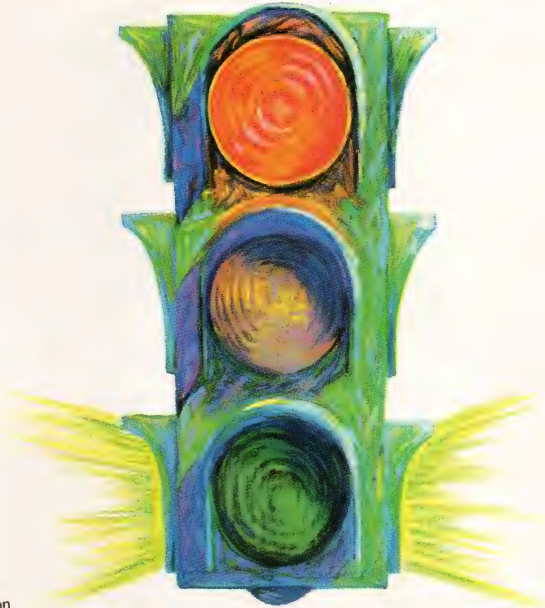
DC
DENSITRON
CORPORATION

**2540 West 237th Street
Torrance, CA 90505
(213) 530-3530
FAX: G2/G3: 213-534-8419
TELEX II: 910-349-6200
Europe/UK: (0959) 76600**

CIRCLE NO 255

INTEL FLASH MEMORIES HELP YOU SEE THE LIGHT.

Now it's easy to reprogram a traffic control system.
Cost-effectively. Only with an Intel Flash memory.
Just call 800-548-4725 (Lit. Dept. 463).



intel

©1988 Intel Corporation

CIRCLE NO 83

Infrared Industries can see it your way.

**I.R. Filters
1.0-6.0 μ**



Interference filters for use in Interferometry, Radiometry, Communications, Analytical Instrumentation, Industrial and Process Control, Laser Applications, Astronomy, Missile Guidance and Fuzing, and Computer Applications. Infrared Industries has a proven capability in the design, development and production of optical interference filters and other multi layer film coatings. To users of thin film products, Infrared Industries offers years of application know-how, service and reliability. Call today for assistance on your application needs.



RöSPATCH

Infrared Industries, Inc.

Subsidiary of RöSPATCH

12151 Research Parkway
Orlando, FL 32826
(305) 282-7700
FAX (305) 273-9046
TELEX 568908

**See us at
SPIE Orlando '88**

The supplier for all your infrared technology needs—application through testing.

PRODUCT UPDATE

Disk drive offers 25M bytes of removable storage

The Model I325 Floptical disk drive is a removable-disk storage system in a 3½-in. format. It provides 25M bytes of unformatted disk capacity and 20.8M bytes of formatted memory. Combining magnetic recording and the high track densities of an optical servomechanism, the drive delivers the best features of both technologies.

Providing portability, data security, and unlimited storage capacity, the drive combines the benefits of a removable, flexible medium with the low cost of a 20M-byte drive. Servo techniques developed for compact disks let the drive employ floppy-disk-drive elements such as spindle- and stepper-actuator motors, disk-loading mecha-

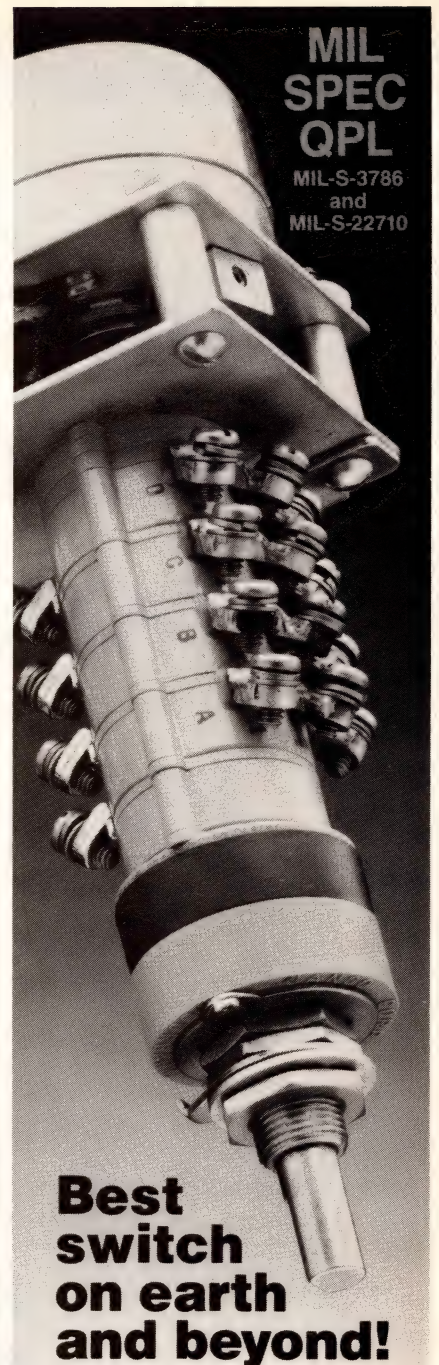
nisms, and spindle clamps. This design translates to cost savings in production.

The drive accepts a double-sided, high-density diskette. The manufacturer optically inscribes 1250 concentric grooves that are spaced approximately 20 µm apart. This arrangement provides a track density of 1250 tpi. Track densities of conventional magnetic floppy-disk drives range from 48 to 135 tpi; pure optical disk drives have densities over 15,000 tpi.

Because the tracks are invulnerable to erasure, the encoded optical tracks on the floppy's medium provide the servo for the drive. In addition, you don't need a defect-free servo pattern as you do in a



Combining magnetic recording with optical servo tracking, the Model I325 Floptical disk drive provides a low-cost, 20M-byte storage system with removable flexible medium.



Best switch on earth and beyond!

Shooting for the moon?

Our rotary switches have been there and back. And on almost every NASA project since the space program began.

We make everything from micro-miniature rotary selector switches to totally enclosed explosion-proof power selector switches, for major airframe and aerospace contractors all over the globe.

And, if we don't have what you need, we can design and custom build a switch to your exact specifications.

Even if they're out of this world.

Janco
An ESOP Corp.

P.O. Box 3038, 3111 Winona Avenue
Burbank, CA 91504 (818) 846-1800
TWX 910-498-2701 FAX (818) 842-3396

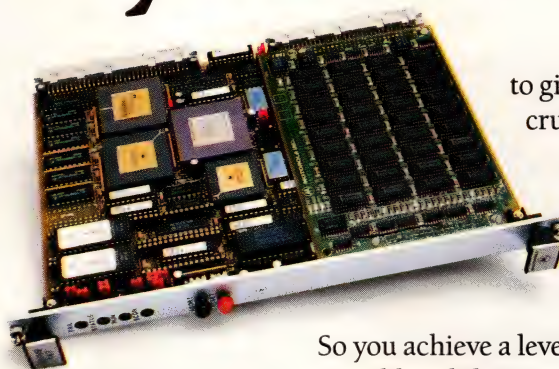
CIRCLE NO 265

“Their new 030 board isn't really a single-board computer. It's a single-board system.”

OEMs weren't prepared for the level of *functionality* our new MVME147 processor module delivers. On one standard VME card, it packs virtually all the functions you need to build a small, multi-user system.

How? Mainly through ASICs like the single-chip VMEbus interface and Peripheral Channel Controller. Plus high-density on-board DRAM (4 or 8 Mbytes), SCSI interface and Ethernet chip set. To even come close in functionality, it would take as many as *five* conventional modules.

Besides which, the 147 outperforms everything in sight. It takes maximum advantage of Motorola's new 32-bit MPU—the MC68030—coupled with a floating-point coprocessor. Both running at up to 25 MHz,



to give you outstanding number-crunching power.

And since the 147 features both UNIX® and real-time operating system support, you can plug it into your existing 020-based architecture and software base.

So you achieve a level of integration never before possible, while protecting your existing investment. All of which gives you unprecedented price/performance advantages for just \$3747 in OEM quantities of 100.

To get an idea of what the future of VME looks like, call us today—toll free: 1-800-556-1234, Ext. 230; in California, 1-800-441-2345, Ext. 230. Or write: Motorola Microcomputer Division, 2900 Diablo Way, Tempe, AZ 85282.

UNIX is a registered trademark of AT&T.



MOTOROLA Microcomputer Division

Approaching our technology from your point of view.

UPDATE

magnetically encoded servo. The drive records data on the magnetic medium between the servo tracks. A magnetic head reads and writes data at a recording density of 23.3k bpi.

Closed-loop optical servos enable the head to follow any data-track eccentricities caused by the drive or the medium. The servo uses LEDs similar to those in compact disks. To provide a position-error signal, the servo tracks the LED's reflected light through a low-cost optical lens onto a quad-element photodetector. The average seek time for the drive is 65 msec.

Before production, the company modifies a standard 3½-in. removable disk so that medium manufacturers don't have to alter their manufacturing processes. Using a proprietary servo formatter, the vendor licenses manufacturers to supply the diskettes.

The drive comes with an embedded disk controller and a common-command-set SCSI. The controller includes provisions for data formatting, error checking and correction, and defect mapping. For an IBM PC, PC/XT, PC/AT, or compatible computer without a SCSI host adapter, the company provides an optional host adapter. The drive is compatible with Apple's SCSI.

The company currently offers the units in evaluation-unit quantities. Volume production will begin in the fourth quarter of 1988. The disk drives will cost less than \$250 (OEM qty).—**John Gallant**

Insite Peripherals, 2363 Calle del Mundo, Santa Clara, CA 95054. Phone (408) 727-8484. FAX 408-727-7917.

Circle No 706

Test Our Mettle...

If you are looking for rugged performance in airmovers, these precision all-metal venturi fans from COMAIR ROTRON are the answer.

As quiet as they are tough, our new Sprite® DC (3.14" square x 1.645" deep with 17 to 35 CFM) and Whisper® XL DC (4.7" square x 1.5" deep with 55 to 85 CFM) join the Muffin® XL DC (4.7" square x 1.5" deep with 85 to 120 CFM). All come with ball or sleeve bearings and you can choose terminal or lead wire equipped models available with Fan Performance Sensors (FPS) or Tachometer output options in 12, 24 or 48 VDC. For even greater noise reduction, the Whisper® XL DC and Muffin® XL DC come with our unique Feathered Edge™ blade design.

COMAIR ROTRON. The first name in forced convection cooling technology.



For literature only call (800) 367-2662. In NYS and for product or technical assistance, call our Application Engineering Dept. at (914) 246-3615.

COMAIR ROTRON

a KLI company

12 North Street, Sawyer Industrial Park, Saugerties, NY 12477-1096
Telephone: (914) 246-3615 TWX 910-333-7572 Telex 551496

CIRCLE NO 256

INTEL EMBEDDED CONTROLLERS ARE GOOD FOR PLANTS.

Now you can drive a factory control system with a fraction of the processors. If it's designed with a member of Intel's 80960 family. Just call 800-548-4725 (Lit. Dept. 437).

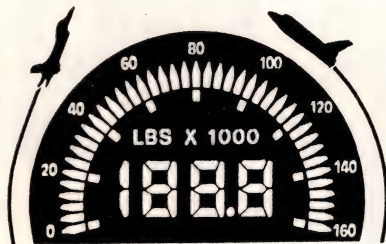


©1988 Intel Corporation

intel

CIRCLE NO 87

DICHROIC LCDs — THE CLEAR CHOICE FOR AVIONICS



Advanced phase-change displays for commercial, military and aerospace, encompassing one or more of the following: Dual layers, anti-glare coating, NVG adaptability, integral heater, EMI shield and temperature sensor.

Guest-host options are available.

LEADING THE WAY IN DISPLAY TECHNOLOGY

POLYTRONIX, INC.

805 ALPHA DR. • RICHARDSON, TX 75081
214/238-7045 • FAX 214/644-0805

CIRCLE NO 90

Be An Author!

When you write for EDN, you earn professional recognition. And you earn \$75 per published magazine page.

EDN publishes how-to design application information that is read by more than 137,300 electronics engineers and engineering managers worldwide. That's an audience that could belong to you.

If you have an appropriate article idea, send your proposal and outline to: John Haystead, 275 Washington Street, Newton, MA 02158-1630.

For a FREE EDN Writer's Guide—which includes tips on how to write for EDN and other technical publications—please circle number 800 on the Information Retrieval Service Card.

EDN

First in Readership among Design Engineers and Engineering Managers in Electronics.

PRODUCT UPDATE

Low-cost PC clone serves as real-time system

Configured as a real-time software-development workstation, the System 120 costs \$9250. The development system runs the vendor's compilers, assemblers, debuggers, monitor ROMs, editors, and real-time operating systems. In addition, the workstation can control proprietary in-circuit emulators and logic and software-performance analyzers. All the code that you develop will run on the company's Multi-bus systems and the workstation.

The workstation employs a 16-MHz 80386 μ P and the IBM PC/AT backplane of the vendor's System 301 PC/AT clone. It comes with a 2M-byte RAM, a 360k-byte floppy-disk drive, and a 40M-byte hard-disk drive. You can expand the RAM to 16M bytes and the hard disk to 80M bytes. In addition to the company's iSDM monitor ROM, the workstation comes with a clone BIOS ROM. The workstation can communicate over the DOS Open-Net LAN. The maker claims that the workstation can use most IBM PC/AT cards in its eight expansion slots.

The workstation's software package comprises both a configurable and a preconfigured iRMX II.3 operating system, PL/M, a 386 assembler, the AEDIT screen editor, and the Soft-Scope II source-level debugger. You can target real-time development for the host workstation or for other systems that use iRMX. Other languages such as Fortran, Pascal, and C are available.

The iRMX II operating system used in the System 120 provides programming facilities for interrupt management with custom exception handlers; support for multiple real-time tasks; preemptive, priority-based scheduling with round-robin (time-slice) scheduling within a priority level; and intertask communication through mailboxes and semaphores. Diskless OEM versions are available for \$3800 (50).

—Charles H Small

Intel Corp, Literature Dept
#W464, Box 58065, Santa Clara, CA
95052. Phone (800) 548-4725.

Circle No 704



The System 120 is an IBM PC/AT clone that comes with a complete line of real-time software-development tools.

The hot single shot.

The HP 54111D digitizing oscilloscope has your numbers: 1 gigasample/s*, 250 MHz single-shot and 500 MHz repetitive bandwidth.

The HP 54111D brings you the blazing speed and complex waveform triggering you need to capture those elusive glitches that cause headaches.

The HP 54111D is loaded with features you can appreciate: simultaneous two-channel capture; 8K memory per channel; up to eight bits of vertical resolution; waveform math which now includes A vs B, A \times B, and integrate; and the advantages of HP digitizing technology including automatic answers, one-button hard copy output, auto-scale, digital storage, and HP-IB programmability (waveform capture and transfer now three to six times

faster in ATE applications).

Plus the exceptional reliability you've come to expect from HP scopes, and extended warranty coverage as well.

Call HP today!
1-800-752-0900, ext. 215S.

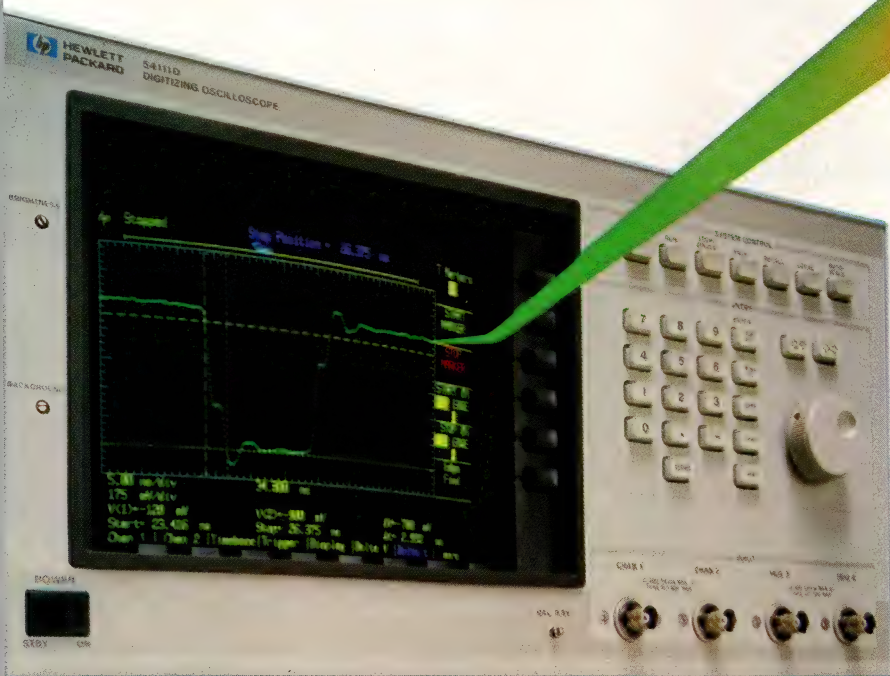
We'll send all the details including Application Note *Sub-nanosecond Single-shot Digitizing Using The 54111D*, HP 54111D Data Sheet, and our brochure *Feeling Comfortable with Digitizing Oscilloscopes*. Or contact your local HP sales office listed in the white pages and ask for your HP rep.



HP-IB: Not just IEEE-488, but the hardware, documentation and support that delivers the shortest path to a measurement system.

© 1988 Hewlett-Packard Co. E115801/EDN(A)

*See our Application Note on 2 gigasample/s performance.

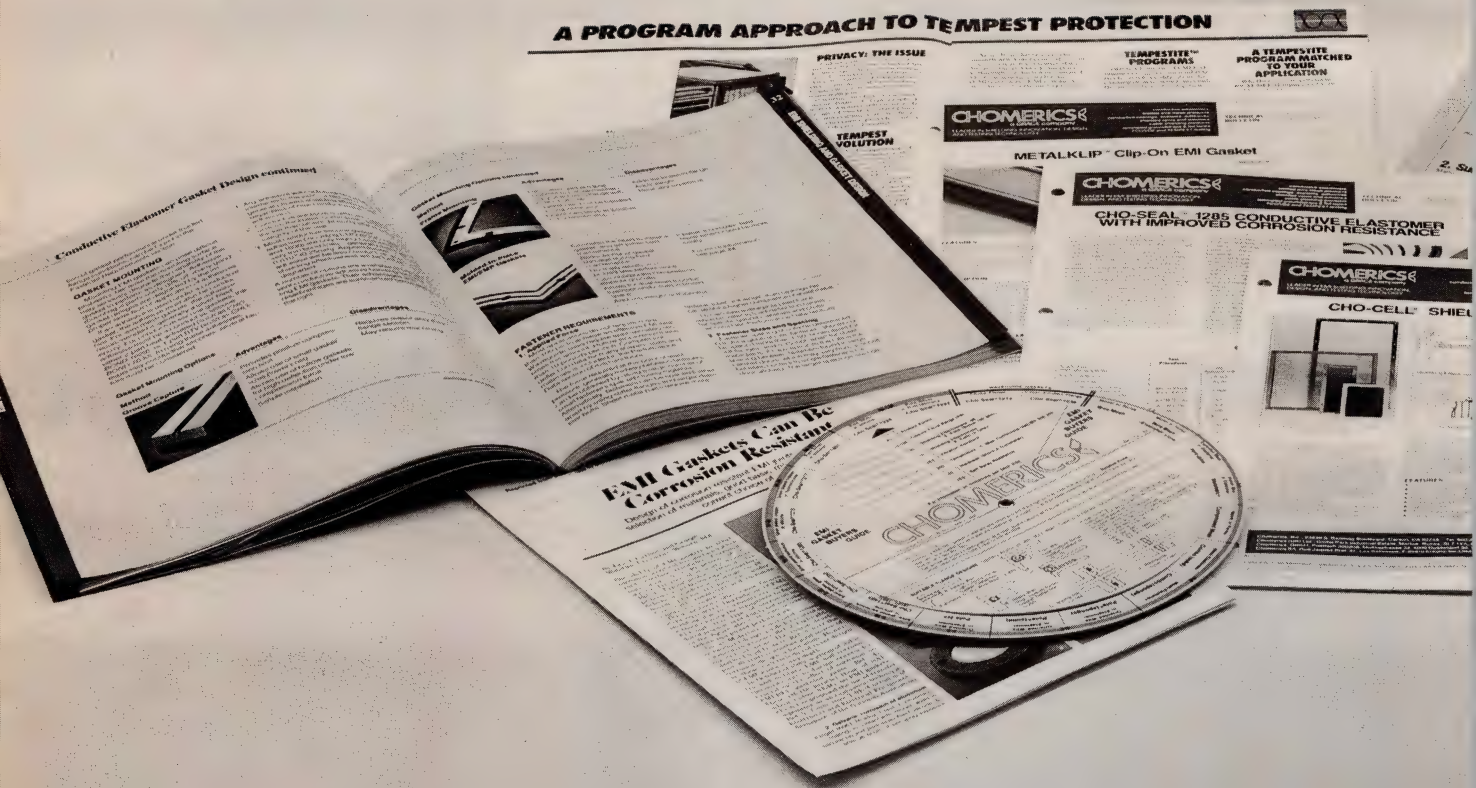


**HEWLETT
PACKARD**

WE NEVER STOP
ASKING
What if...

Before you tackle EMI shielding problems...

CHECK OUR REFERENCES



Whether you have a new electronic system to shield, or must retrofit shielding onto an existing system, Chomerics can help.

Just as our EMI shielding products (gaskets, compounds, laminates, vents, and windows) have set the industry's standards for 25 years, so too has the wealth of clearly presented technical information we make available to you. From our comprehensive EMI Shielding Handbook, down to the simplest technical data sheet, you'll get the facts you need to make the best cost/performance choices.

READER'S CHOICE

To assist you in solving your EMI problems, we've organized some key references around major areas of interest. We invite you to circle the corresponding number(s) on the reader service card.

- **Incorporating EMI shielding in your design**

CIRCLE NO. 39

- **Applications and material selection**

CIRCLE NO. 40

- **FCC/VDE compliance for commercial equipment**

CIRCLE NO. 41

- **MIL-SPEC compliance for military systems**

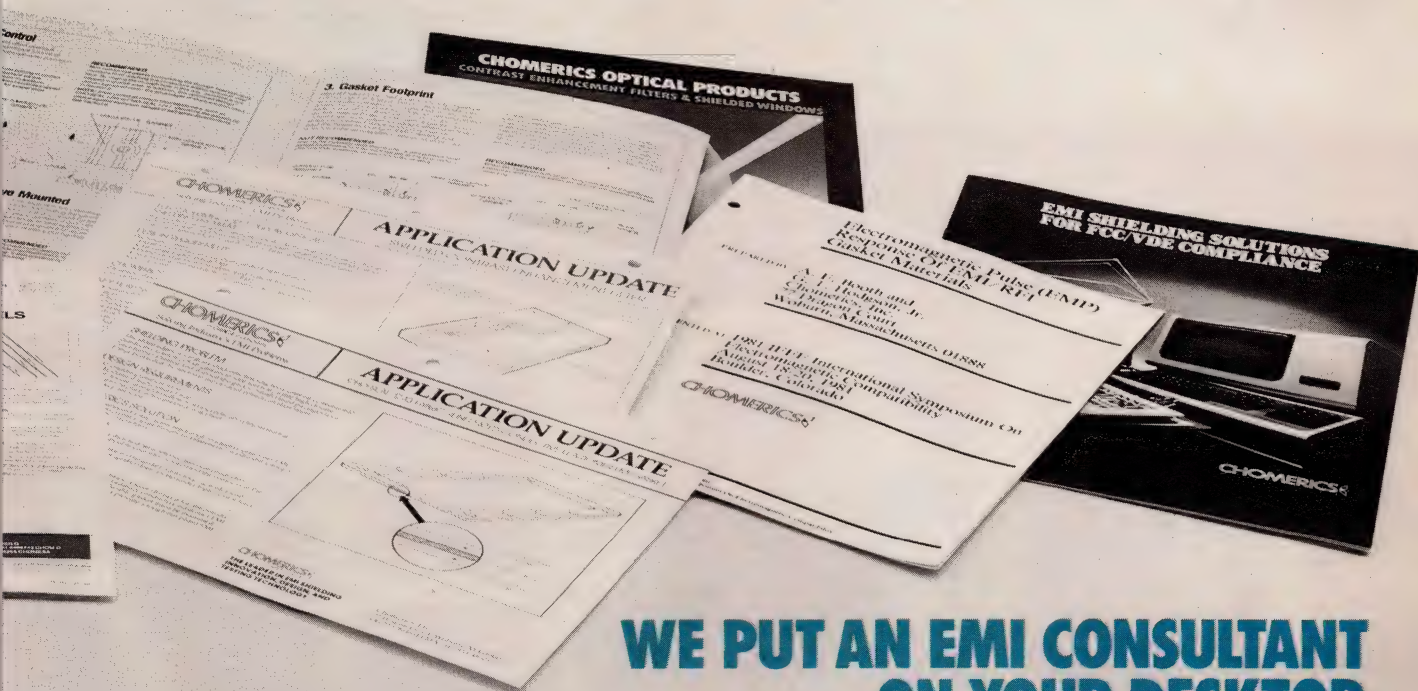
CIRCLE NO. 42

- **TEMPEST applications**

CIRCLE NO. 43

- **EMI testing**

CIRCLE NO. 44



WE PUT AN EMI CONSULTANT ON YOUR DESKTOP.

CHOMERICS

a GRACE company

Chomerics, Inc.
77 Dragon Court
Woburn, MA 01888-4014
Tel: 800-225-1936
(In MA: 617-935-4850)
TWX: 710-393-0173
Fax: 617-933-4318

Chomerics (UK) Ltd.
Unit 8, First Avenue
Globe Park Industrial Estate
Marlow, Bucks., SL7 1YA
ENGLAND
Tel: (06284) 6030
Telex: 849817 CHOMER G
Fax: (06284) 76303

Chomerics GmbH
Postfach 320208
Moltkestrasse 32
4000 Dusseldorf 30,
WEST GERMANY
Tel: 0211/488001
Telex: 5589743 CHOM D
Fax: 0211/483109

Chomerics S.A.
Rue Jacques Brel
Zone Industrielle Les Bellevues
95610 Eragny-sur-Oise
FRANCE
Tel: (1)30.37.63.30
Telex: 608255F CHOMESA
Fax: (1)30.37.46.36

A Perfect 10 In GaAs Prescalers.

Nobody even comes close to the speed of NEC's new 10 GHz GaAs prescaler. In fact, these are the highest speed commercial prescalers available anywhere.

You can choose from a family of four to meet your specific needs:

Part No.	Typ. Freq. Range	Division
UPG501B	1.5-5 GHz	4
UPG502B	1-5 GHz	2
UPG503B	4-10 GHz	4
UPG504B	2-10 GHz	2

You can also depend, of course, on the high reliability that NEC is known for.

These new ultra high-speed prescalers are available in production quantities. The UPG501 and UPG502 are ideal for use in synthesizers that are part of instrumentation and microwave equipment. The UPG503 and UPG504 are recommended for use in test and measurement instruments. Call for more information, application support, or data sheets.

Given the speed of these parts, it's no wonder they're going so quickly.

NEC[®]

California Eastern Laboratories

3260 Jay Street, Santa Clara, CA 95054 (408) 988-3500

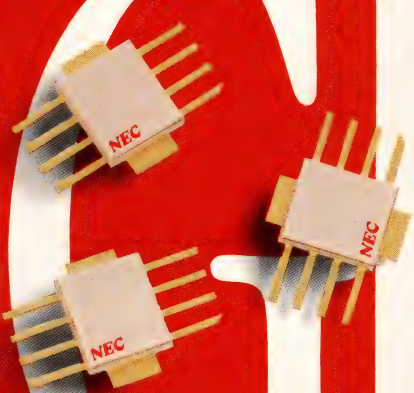
Western (408) 988-3500 **Eastern** (301) 667-1310

Canada (613) 726-0626

Europe NEC Electronics GmbH 0211/650301

CIRCLE NO 91

10GHz



Ultrafast Voltage Comparators

AD96685/AD96687

FEATURES

2.5ns Propagation Delay
Consistent 50ps Propagation Delay Dispersion
2.5ns Latch Setup Time
Stable Transition Zones
Low Power Dissipation

APPLICATIONS

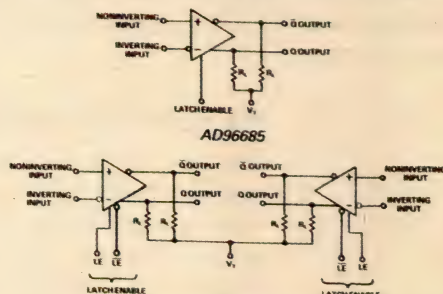
High Speed Triggers
High Speed Line Receivers
Peak Detectors
Threshold Detectors

PRODUCT DESCRIPTION

The AD96685 (single) and AD96687 (dual) are ultrafast voltage comparators with short, consistent propagation delays and setup times. Both devices feature an incredible 50ps propagation delay dispersion for any overdrive from 100mV to 1V.

Propagation delays for both units are 2.5ns, and both have stable transition zones. They are manufactured with a high performance bipolar process and have differential inputs and complementary outputs fully compatible with ECL logic levels. Their 30mA output currents are capable of driving 50Ω terminated transmission lines; a latch enable input allows operation in either latched mode or a track mode.

There are six models of the single AD96685 comparator; three operate over an industrial temperature range of -25°C to +85°C, the other three are for extended temperatures of -55°C to +125°C. Two of the four models of the dual AD96687 unit operate over industrial temperatures, and the other two are for extended temperatures.



THE OUTPUTS ARE OPEN EMITTERS, REQUIRING EXTERNAL PULL-DOWN RESISTORS. THESE RESISTORS MAY BE IN THE RANGE OF 50Ω - 200Ω CONNECTED TO -2.5V OR 200Ω - 2000Ω

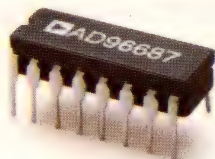
AD96687

Functional Block Diagrams

PRODUCT HIGHLIGHTS

1. Propagation delay dispersion of 50ps is the lowest available. Because of this extremely low dispersion, the AD96685 and AD96687 comparators can be used to make very fast, accurate and repeatable measurements despite wide variations in input overdrive; this improves performance for systems using these units.
2. The ultrafast latches allow the comparators to operate in a high speed sample (track)-and-hold mode. When the latch is used properly, input pulses of extremely short duration can be accurately detected and held for additional processing.
3. Since the latch operates on the input state of the comparator, the output state is dependent on the input at the time of the LATCH ENABLE command. This contrasts with strobed comparators, which operate on the output regardless of the input conditions at the time of the strobe.
4. Due to the elegant design of the AD96685 and AD96687 comparators, oscillation-free performance extends over a wide variation of input slew rates and overdrive conditions. This characteristic is not available in many other pin-compatible devices; they often have severe restrictions on how they can be used.

COMPARED TO WHAT'S ON THIS PAGE, NO OTHER COMPARATORS ARE EASIER TO USE.



If the output from your present comparator makes it difficult to use, take a look at the incomparable AD96685 and AD96687. They're the only comparators whose propagation delays remain constant to within 50 picoseconds for any overdrive from 100mV to 1V, so you always get consistent output.

The AD96685 and AD96687 also give you consistent speed, since they switch in 2.5ns, with a setup time of 0.5ns. And they have remarkably stable transition zones, which minimize oscillation.

But speed isn't achieved at the expense of power.

The single AD96685 dissipates a mere 118mW, and the dual AD96687 needs just 237mW.

In addition, the AD96685 and AD96687 each have an offset voltage of 1mV typical for a consistent starting point, and an input voltage range of -2.5V to +5V.

Now despite all these advantages, you won't have to change your board design for the AD96685 and AD96687. They're ECL-compatible and drop-in replacements for standard devices. If you'd like a further comparison of the AD96685 and AD96687, call your nearest Analog Devices sales office.



Analog Devices, Inc., One Technology Way, P.O. Box 9106, Norwood, MA 02062-9106; Headquarters: (617) 329-4700; California: (714) 641-9391, (619) 268-4621, (408) 559-2037; Colorado: (719) 590-9952; Maryland: (301) 992-1994; Ohio: (614) 764-8795; Pennsylvania: (215) 643-7790; Texas: (214) 231-5094; Washington: (206) 251-9550; Austria: (222) 885504; Belgium: (3) 237 1672; Denmark: (2) 845800; France: (1) 4687-34-11; Holland: (1620) 81500; Israel: (052) 911415; Italy: (2) 6883831, (2) 6883832, (2) 6883833; Japan: (3) 263-6826; Sweden: (8) 282740; Switzerland: (22) 3157 60; United Kingdom: (932) 232222; West Germany: (89) 570050

READERS' CHOICE

Of all the new products covered in EDN's May 26, 1988, issue, the ones reprinted here generated the most reader requests for additional information. If you missed them the first time, find out what makes them special: Just circle the appropriate numbers on the Information Retrieval Service card, refer to the indicated pages in our May 26, 1988, issue, or use EDN's Express Request service.



◀ CASSETTE MEMORY

The 234/334C cassette memory system for the STD bus comes in two versions: Model 234-1 comes with a TTL bus card, and Model 334C-1 is the CMOS bus version. (pg 220).

Enlode Inc.
Circle No 603

68HC11 EMULATOR

The 68HC11 emulator aids microcode development. It draws power from the 52-pin PLCC socket on your board via one cable (pg 260).

Xytek Industries Inc.
Circle No 602

CAD PACKAGE

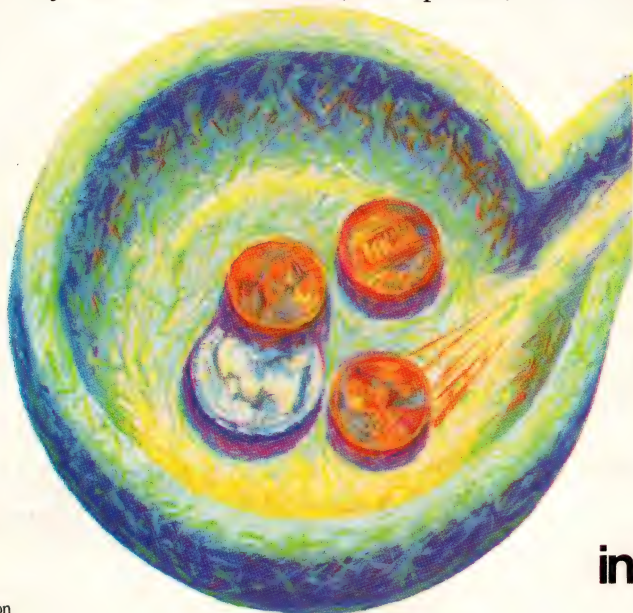
The Resicalc CAD package lets you design through-hole, surface-mount, or leadless-carrier resistor networks on an IBM PC or compatible system (pg 94).

Ericsson Business Area Components.

Circle No 606
Ericsson Components.
Circle No 607

INTEL FLASH MEMORIES. A FORCE FOR CHANGE.

Now you can update a cash register with the latest prices.
Cost-effectively. Only with an Intel Flash memory.
Just call 800-548-4725 (Lit. Dept. 463).



intel®

RISC CHIP SET

The 88000 chip set takes advantage of the silicon-saving RISC architecture to integrate all the major CPU-board functional blocks (pg 103).

Motorola Microprocessor Products Group.

Circle No 604
Motorola Microcomputer Div.
Circle No 605

ACCELEROMETER

The SXL Series accelerometers employ a 0.16×0.16-in. sensor chip and have 200g measurement capability (pg 240).

Sensym Inc.
Circle No 601

The CMOS LED display leader has acquired a valuable stamp.

And the valuable advantages are all yours!

Hi-rel design engineers will appreciate the superior quality and reliability our DESC-approval represents. This, combined with our broad product offering, makes us an unmatched choice for satisfying your most stringent LED alphanumeric display requirements.

Here's your new military lineup:

Small alphanumeric displays

- .15" and .20" dot matrix characters, red, High Efficiency Red, yellow and green
- Serial input

Intelligent display

- .15" segmented characters, red
- 64 ASCII

Programmable displays

- .25" dot matrix characters, high efficiency red and green
- 96 ASCII

All are user-friendly four character displays with on-board CMOS, sealed in hermetic packages, and tested to MIL-D-87157 and TXVB.

When you're looking for sophisticated, quality alphanumeric displays, look to Siemens. Our DESC-approved line will satisfy the toughest standards of all. Yours.

For more information, call (408) 257-7910 today. Or write: Siemens Components, Inc., Optoelectronics Division, Military Marketing Department, 19000 Homestead Road, Cupertino, CA 95014

National Distributors: Hall-Mark and Marshall

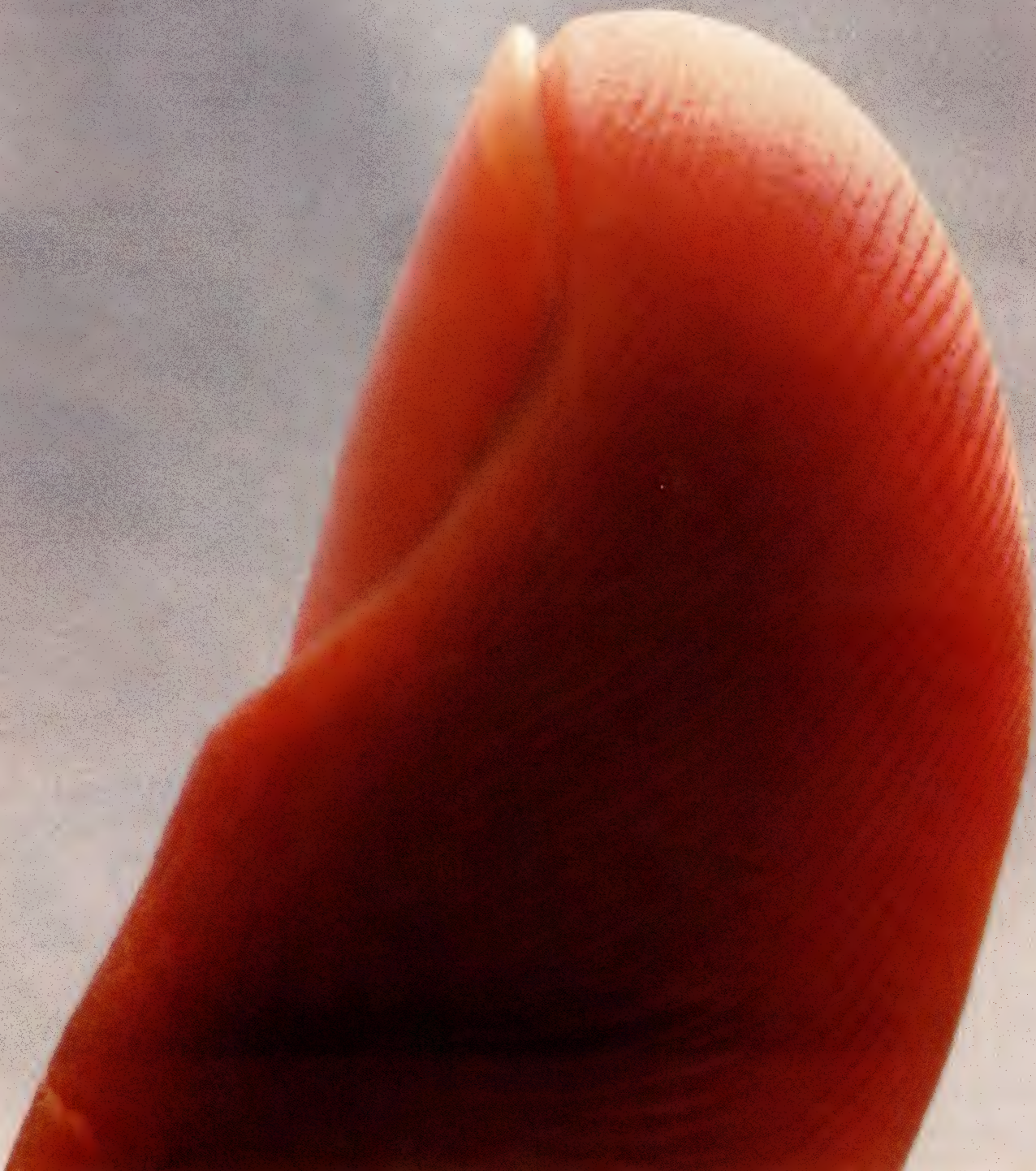
Regional Distributors: Advent Electronics, Inc., Almo Electronics, Insight Electronics, Quality Components, Summit, Western Microtechnology

**Siemens...
your partner for the future.**

© 1988 Siemens Components, Inc.
CG/2000-453 WLM 746



How to please significant portion



e a small but of your customers.

Pushbutton-operated devices are much more marketable when the buttons respond in satisfying ways to the user's touch.

So we made our new SLP control panels a touch more responsive.

We increased button travel to a more comfortable .050".

And we incorporated an enhanced conductive rubber pad, tested to ten million operations, that rewards the finger with a satisfying snap back when a button is actuated.

The result is a control panel that adds to a user's comfort and confidence, for about the same price as those that generate feelings of vagueness and uncertainty.

But that's not the only bright feature of these new controls.

You can also get them in full-face, LED lighted versions that show up unmistakably, even in broad daylight.

And each button can be made to light independently of its on/off status,

enabling the panel to guide a user through a sequence of operating steps.

These new panels are available off-the-shelf in several standard arrays, or in custom packages with microprocessors, visual displays, special enclosures, or attachment cable included.

Making controls more responsive is just one of the many ways we can help you build competitive advantages into your products.

To make your designs easier to sell, more satisfying to use, or more cost-efficient to produce, call us at 815-235-6600.



Selective button lighting helps guide a user through a sequence of operating steps.



Actuator travel of .050" is more than twice that of conventional low-profile keypads.



Together, we can find the answers.

MICRO SWITCH
a Honeywell Division

Low Resistance Power Resistors

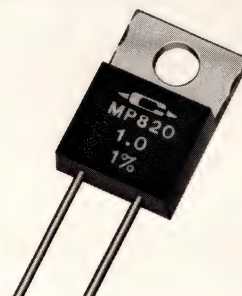
Non-Inductive with Values Down to 0.1Ω

Type MP Kool-Tab™ Power Film Resistors

20 Watts in the TO-220 Package

NEW

- *Now available as low as 1 Ω*
- **Non-Inductive**
- Made with Micronox® resistance film
- 20 Watts at 25°C case temperature
- Standard resistance tolerance of ±1%.



Type MV Power Film Resistors

Axial Lead Design with Very Low Resistance

NEW

- *Now available as low as 0.1 Ω*
- **Non-Inductive**
- Made with Micronox® resistance film
- Wattage ratings from 2 watts to 10 watts
- Standard resistance tolerance of ±1%

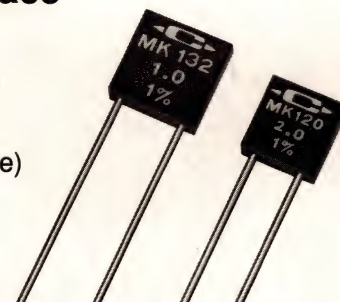


Type MK Precision Power Film Resistors

Radial Lead Design Takes Less Board Space

NEW

- *Now available as low as 1 Ω*
- **Non-Inductive**
- Made with Micronox® resistance film
- 3/4 watt (CK06 size) and 1/2 watt (CK05 size)
- Full power rating at 125°C
- Standard resistance tolerance of ±1%



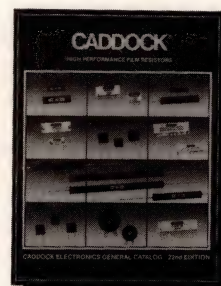
*More high
performance
resistor products
from*

CADDOCK
ELECTRONICS, INCORPORATED

Call or write for your copies of product data sheets.

Applications Engineering
Caddock Electronics, Inc.
1717 Chicago Avenue
Riverside, Calif. 92507
(714) 788-1700

Also ask for the Caddock General Catalog which includes specifications on over 200 models of high performance resistor products.



or
apacitors
st, call
EMET
rst!



ust tell us where in the world you
nt them delivered, and stand back.
ousands of capacitors? Millions?
T scheduling? Count on it.
and our caps solve problems. Our
amic chips resist cracking caused by
duction heat and shock. Our three-
ded tantalums prevent blown cir-
s — because you just can't put 'em
wrong.

More reasons to call? Huge surface-
unt selection. More MIL-39003
ifications than anyone else has.
ighest reliability in tantalum, plus
amic and film capacitors. KEMET is
choice for your commercial and
itary capacitor requirements.
and for fast delivery. Amazingly fast.



At KEMET, qu
We spend a lo
next KEMET c
tantalum, cer
as reliable as

Our comm
production, a
stringent con
training of pe
creative min

Modern K
offer some
automated
quality cap
sophistical
and built in

Through
ment Prog
ing and m
broadene
of quality
industry.

KEME
of the q
guaran
Detailed
shipped
inspect

And
tion wil
way in
roduc
minia
perfo
coatir

All
We s
next
tant
as r
pro
stri
tra
cre

of a
c

KEMET®

CAPACITORS
KEMET Capacitors • P. O. Box 5928 • Greenville, South Carolina 29606 • 803/963-6300

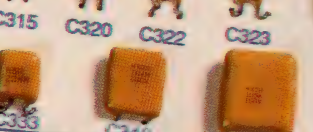
CERAMIC

CHIPS (Surface Mounted Device) 1pF-2.2µF



CONFORMALLY COATED RADIAL

Golden Max 1pF-6.8µF



CONFORMALLY COATED AXIAL

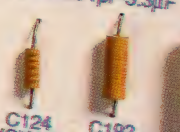
Aximax 10pF-1µF



MOLDED RADIAL 1pF-3.3µF



MOLDED AXIAL 1pF-3.3µF



FILM

Metallized Polycarbonate



Flat Kap. .001-1µF
F110, F120, F130
(4 Case Sizes Available)

F141, F241 (CRH01-5), F242 (CRH06-0),
F245 (CHR01A, D, G, K, N), F246 (CHR01B, E, H, L, P),
F247 (CHR01C, F, J, M, R), F248 (CHR10)

TANTALUM

CHIPS (Surface Mounted Device)

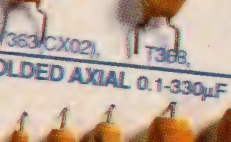


CONFORMALLY COATED RADIAL

T350 Series Ultradip 0.1-680µF



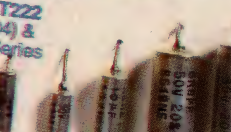
MOLDED AXIAL 0.1-330µF



MOLDED RADIAL



HERMETICALLY SEALED



LEADTIME INDEX

Percentage of respondents

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Last month's average (weeks)	Average (weeks)
TRANSFORMERS								
Toroidal	0	13	56	25	0	6	10.6	10.6
Pot-Core	0	11	55	28	0	6	10.9	12.5
Laminate (power)	0	32	37	26	0	5	9.3	11.7
CONNECTORS								
Military panel	0	0	27	55	9	9	16.0	11.5
Flat/Cable	9	47	35	9	0	0	5.1	5.7
Multi-pin circular	0	28	38	28	6	0	9.6	9.2
PC (2-piece)	7	20	46	27	0	0	8.4	6.7
RF/Coaxial	6	22	39	33	0	0	8.8	7.8
Socket	11	37	33	19	0	0	6.4	6.6
Terminal blocks	8	57	23	12	0	0	4.9	4.0
Edge card	5	26	58	11	0	0	6.9	6.0
D-Subminiature	12	24	48	12	4	0	7.2	6.0
Rack & panel	0	17	66	17	0	0	8.3	9.0
Power	0	22	57	21	0	0	8.3	7.6
PRINTED CIRCUIT BOARDS								
Single sided	5	49	41	5	0	0	5.0	5.8
Double sided	0	38	56	6	0	0	6.2	6.7
Multi-layer	0	8	64	28	0	0	9.7	10.6
Prototype	0	83	10	7	0	0	3.5	3.7
RESISTORS								
Carbon film	30	24	22	24	0	0	6.0	4.3
Carbon composition	24	28	16	32	0	0	6.9	3.5
Metal film	23	25	26	26	0	0	6.7	4.6
Metal oxide	16	32	26	26	0	0	6.8	5.4
Wirewound	9	28	36	27	0	0	7.7	6.3
Potentiometers	0	44	33	23	0	0	7.2	6.1
Networks	8	42	25	25	0	0	6.8	7.0
FUSES								
	44	28	20	8	0	0	3.4	3.2
SWITCHES								
Pushbutton	12	42	31	15	0	0	5.7	5.9
Rotary	0	45	38	17	0	0	6.6	5.8
Rocker	5	42	32	21	0	0	6.7	6.9
Thumbwheel	0	47	29	24	0	0	7.1	8.2
Snap action	5	42	32	21	0	0	6.7	5.9
Momentary	12	41	35	12	0	0	5.5	6.5
Dual-in-line	13	31	37	19	0	0	6.6	7.7
WIRE AND CABLE								
Coaxial	26	59	11	4	0	0	2.7	5.2
Flat ribbon	24	56	16	4	0	0	3.0	4.4
Multiconductor	17	54	25	4	0	0	3.7	5.4
Hookup	33	48	15	4	0	0	2.8	3.3
Wirewrap	30	45	15	10	0	0	3.7	4.8
Power cords	15	52	22	11	0	0	4.5	5.1
POWER SUPPLIES								
Switcher	0	20	60	20	0	0	8.4	8.6
Linear	8	25	50	17	0	0	7.2	8.0
CIRCUIT BREAKERS								
	10	25	45	15	5	0	7.8	8.8
HEAT SINKS								
	9	48	26	17	0	0	5.7	6.7
BATTERIES								
Lithium coin cells	6	52	24	12	6	0	6.4	6.5
9V alkaline	20	47	20	13	0	0	4.6	2.9
Real-time clock back-up	8	25	50	17	0	0	7.2	5.7
RELAYS								
General purpose	14	41	28	17	0	0	5.7	5.6
PC board	8	46	21	25	0	0	6.6	5.5

ITEM	Off the shelf	1-5 weeks	6-10 weeks	11-20 weeks	21-30 weeks	Over 30 weeks	Last month's average (weeks)	Average (weeks)
DISCRETE SEMICONDUCTORS								
Dry reed	14	21	29	36	0	0	8.5	6.3
Mercury	10	10	30	50	0	0	10.6	11.2
Solid state	5	33	33	29	0	0	7.9	9.2
INTEGRATED CIRCUITS, DIGITAL								
Advanced CMOS	0	19	43	38	0	0	9.9	10.1
CMOS	10	28	28	31	3	0	8.5	8.0
TTL	14	20	33	33	0	0	8.3	5.6
LS	23	31	23	23	0	0	6.1	6.5
INTEGRATED CIRCUITS, LINEAR								
Communication/Circuit	8	26	33	33	0	0	8.4	9.1
OP amplifier	22	26	26	26	0	0	6.7	7.6
Voltage regulator	18	32	23	27	0	0	6.8	6.3
MEMORY CIRCUITS								
DRAM 16K	0	7	20	40	0	33	18.3	14.6
DRAM 64K	0	12	22	44	0	22	15.8	14.6
DRAM 256K	0	11	6	39	11	33	20.0	19.5
DRAM 1M-bit	0	13	7	27	20	33	20.5	22.6
SRAM 4K x 4	0	7	27	33	13	20	17.1	15.3
SRAM 8K x 8	0	6	17	32	17	28	19.6	16.6
SRAM 2K x 8	0	6	24	28	24	18	18.3	17.8
ROM/PROM	0	14	29	43	7	7	13.4	13.2
EPROM 64K	0	16	36	26	11	11	13.6	11.4
EPROM 256K	0	19	19	42	10	10	14.3	13.9
EPROM 1M-bit	0	17	17	41	17	8	15.1	15.8
EEPROM 16K	0	15	38	38	0	9	12.2	14.7
EEPROM 64K	0	15	31	46	0	8	12.6	14.1
DISPLAYS								
Panel meters	0	27	53	20	0	0	7.9	7.3
Fluorescent	0	10	45	45	0	0	11.0	10.4
Incandescent	9	28	36	27	0	0	7.7	6.3
LED	26	13	48	13	0	0	6.1	7.1
Liquid crystal	7	7	50	36	0	0	9.9	12.2
MICROPROCESSOR ICs								
8-bit	0	28	28	44	0	0	9.8	8.9
16-bit	0	27	27	46	0	0	10.0	9.2
32-bit	7	13	40	40	0	0	9.8	12.0
FUNCTION PACKAGES								
Amplifier	9	19	45	27	0	0	8.3	8.9
Converter, analog to digital	7	29	29	35	0	0	8.5	9.4
Converter, digital to analog	9	19	36	36	0	0	9.0	9.6
LINE FILTERS								
	9	28	27	36	0	0	8.4	7.9
CAPACITORS								
Ceramic monolithic	13	40	27	20	0	0	6.1	7.0
Ceramic disc	18	32	29	21	0	0	6.3	6.1
Film	19	33	26	22	0	0	6.2	6.4
Aluminum electrolytic	10	29	29	29	3	0	8.3	7.7
Tantalum	16	28	34	19	3	0	7.1	8.0
INDUCTORS								
	0	25	56	19	0	0	8.0	8.5

Source: Electronics Purchasing Magazine's survey of buyers.

EDN August 18, 1988

OUR POWER SUPPLY SURVIVED.



In a Navy test, a Tomahawk cruise missile exploded into a concrete building. When the dust settled, little remained but gravel and fragments of casing.

And the Abbott model C28D0.8 you see here.

Its aluminum baseplate and an adjustment cap were ripped off in the blast. But reconnected on a workbench, the

unit still provided a steady .8 amp of DC current — just as it was designed to.

Abbott Transistor Laboratories, Inc.
2721 South La Cienega Blvd.,
Los Angeles, CA 90034. (213) 936-8185

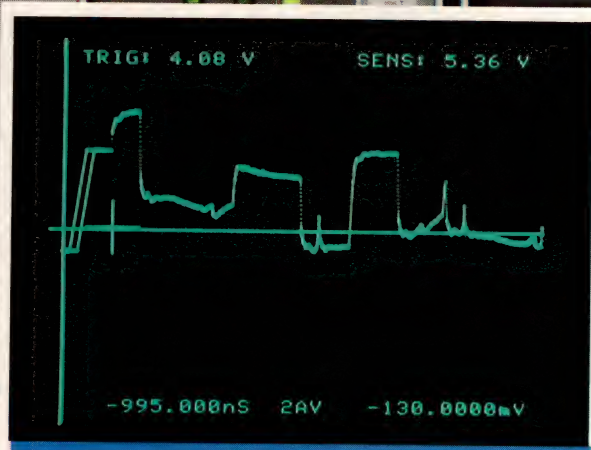
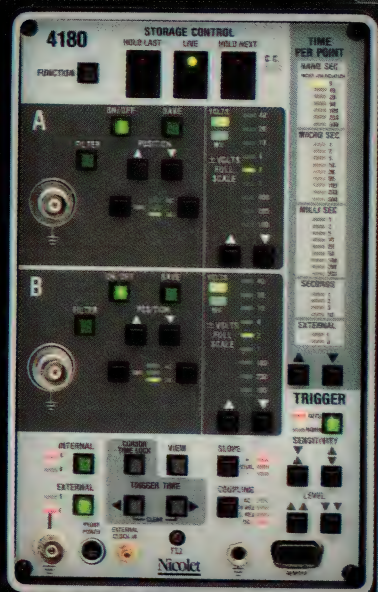
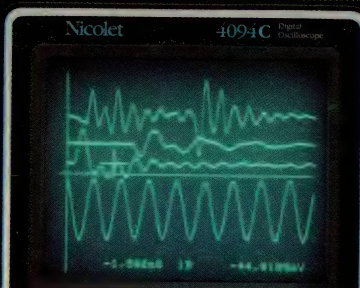
When reliability is imperative®

abbott

MILITARY POWER SUPPLIES



Flexible Triggering An Issue?



Get the Ultimate in Flexibility and Speed!

- *Preview Of Trigger Settings*
- *Operate With Independent Trigger and Timebase Settings for Each Plug-in.*
- *200 MegaSamples per second*
- *Real Time Functions*
- *Zoom to x256*
- *Floppy Disk Storage*
- *PC Software*
- *Downloadable Software Programs*

Flexibility — With Nicolet's 4180 plug-in and 4094C Digital Storage Oscilloscope, you can take the guesswork out of triggering. The Trigger View feature gives you a graphic representation of trigger slope, level and sensitivity superimposed on the actual trigger input signal. What this means for you is easy and accurate trigger setting. Using the 4094C with two 4180's allows four input channels with each two-channel plug-in having its own independent time base and trigger settings. That's flexibility!

Speed — Wideband input amplifiers allow you to capture signals up to a 100MHz bandwidth at digitizing speeds up to 200 MegaSamples per second.

Support — All this with unequalled factory support. As a user, your questions are answered quickly without the need for customer account numbers or other qualification.

Write or give us a call!

Nicolet

INSTRUMENTS OF DISCOVERY

Nicolet Test Instruments Division

5225-2 Verona Road, Madison, WI 53711 608/273-5008 or 800/356-3090

CIRCLE NO 97

EDN August 18, 1988

we never stop
asking

What if...



Now a network analyzer and a spectrum analyzer in one box. From HP.

The HP 4195A Network/Spectrum Analyzer. It's the *one* tool you've been waiting for to make development and production testing of your analog devices easier, more flexible—and at half the price of equivalent dedicated analyzer solutions and less than other combination units.

For the first time, you have a combination analyzer with a balanced set of specifications for both vector network and spectrum analysis functions. And, if that weren't enough, you can use it for *impedance analysis*, too.


The 10Hz to 500MHz range of the HP 4195A make it ideal for audio, base-band, HF, VHF, and IF applications. A unique feature is four-channel spectrum

measurement capability that accommodates four independent inputs. The unit features an internal flexible disk drive, color CRT, User Math, User Defined Functions, User Programs for customization—and it's softkey menu driven, making it extremely friendly. As usual, HP delivers value.

Call 1-800-752-0900, Ext. B215.

Ask for your free data sheet on the HP 4195A Network/Spectrum Analyzer. Find out how we got network and spectrum analysis tools with balanced performance into one box for half the price.

© 1988 Hewlett-Packard Co. E115804/EDN

 **HEWLETT
PACKARD**

The technology and manufacturing processes for flat-panel displays are changing fast—particularly for large-area displays with expanded information content. In choosing a model, however, you need to consider other aspects, too, from brightness and contrast to viewing angles. And don't forget the price—it can decide the issue.



Light weight and compact design are the hallmarks of flat-panel displays. Now manufacturers are also improving their manufacturing materials and processes to raise performance levels and lower costs as well. (Photo courtesy Planar Systems)

Flat-panel displays

Dave Pryce, *Associate Editor*

Flat-panel displays are changing the way we view information, not only in wrist watches and calculators but in bigger applications like portable computers and terminals that require complex graphics. Manufacturers have continued to refine some of the smaller and simpler products that have been around for years, but it's within the realm of displays with large areas and expanded information content that you can see significant trends and sometimes dramatic progress. In these areas, manufacturers are working to make flat-panel displays that are suitable for more and more complex applications, while improving performance levels of those displays and lowering their cost.

The LCD (liquid-crystal display) is well known for its nearly universal use in digital watches and pocket calculators. Perhaps less well known is the use of LCDs and VFDs (vacuum-fluorescent displays) in such applications as automotive dashboards. Many of today's cars—to the dismay of the purist—use LCDs and VFDs to replace traditional analog speedometers, tachometers, and gauges for oil pressure, water temperature, and gasoline. VFDs, along with LCDs and PDPs (plasma display panels), are also frequently used as readouts

in gasoline-station pumps and industrial control equipment. And the LCDs, PDPs, and ELDs (electroluminescent displays) that are available in expanded information content versions are very practical for use in portable computers and in applications that require complicated graphics.

The LCD has probably saved the individual consumer hundreds of dollars in battery replacement costs—its predecessor, the LED (light-emitting diode), burned out batteries at a furious rate. LCDs have more modest power requirements; a digital watch with an LCD typically operates for two years or more on its original battery. Their low power requirements make them particularly suitable for portable computers.

Active-matrix enhances large-area LCDs

One recent development that has contributed to the growing popularity of LCDs is the active matrix. Alphasil Inc, for example, makes custom and semi-custom active-matrix LCDs that contain amorphous-silicon, thin-film transistors (TFTs) that switch individual pixels (dots) on and off; external row- and column-drivers are still required. All of Alphasil's active-matrix flat-panel displays (AMFPDs) offer at least a 10:1 contrast ratio.

AMFPDs are available as reflective, transmissive, or

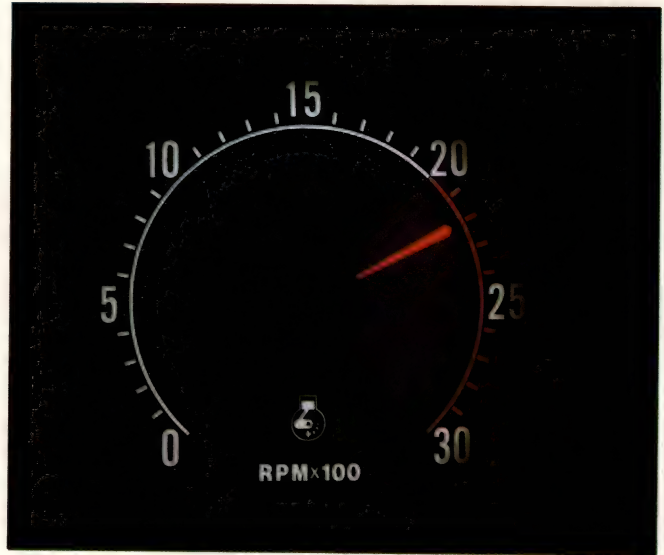
LCDs have probably saved the individual consumer hundreds of dollars in replacement battery costs.

transflective displays. Like most other LCDs, the reflective AMFPDs contain no backlighting. Because reflective units depend on ambient light alone to illuminate the screen, they perform best when that light is high. The transmissive displays are backlit continuously when in use and are thus suited for indoor applications where the ambient light is low. Transflective displays can operate either way; they're most appropriate where displays must operate in a wide range of indoor and outdoor lighting conditions. For backlighting, both the transmissive and transflective screens use a low-power, high-efficiency neon fluorescent tube. Alphasil also offers thin-film electroluminescent (EL) backlighting for situations where the lower surface brightness that the backlighting creates under ambient light is not a problem.

Alphasil's products include AMFPDs with matrices of 640×200 (CGA), 640×350 (EGA), 640×400, 640×480 (VGA), and 640×640 pixels. The 640×350-pixel unit has an active display area of 3.5×5 in. and contains 224,000 pixels with a built-in 2:1 redundancy. According to Alphasil, all of the displays feature a viewing angle of 160° for any pixel, a minimum contrast ratio of 10:1, and power consumption of less than 3W with backlighting. All models have a refresh rate of 60 Hz and include digital and RGB interfaces. These large-area displays, which are available in sizes through 5×5 in., are fairly expensive, and find primary use in military and avionics applications. Prices depend on the particular display; they range from about \$1000 to \$2000 in small quantities.

Panasonic Industrial makes dot-matrix LCD modules that fit the large-area category without using the active-matrix technology. The EDM-DG648A01D (8-in. diagonal) and the EDM-DG64AA41D (9.5-in. diagonal) are both birefringent displays (see box, "A glossary of display terms," pg 144). The 8-in. display has a 640×200-pixel format with an effective viewing area of 6.46×4.886 in. The 9.5-in. display has a 640×400-pixel format with a viewing area of approximately 8.078×5.04 in. These LCD modules can display a sufficient amount of alphanumeric and graphics to replace CRTs in most configurations. The dot size is 0.00827×0.022 in. (0.21×0.56 mm) for the 8-in. display, and 0.011×0.011 in. (0.28×0.28 mm) for the 9.5-in. display. Both modules operate from 5 and 24V dc supplies. For applications in low-light work areas, an optional EL backlight is available. The displays cost from \$200 to \$250 each.

Industrial users are also finding LCDs functional.



This automotive tachometer display is typical of the applications for Taliq Corporation's liquid-crystal film. By combining light-controlling liquid-crystal thin films with graphic overlays and color reflectors, the company can produce complete front-panel assemblies.

Seiko Instruments, for example, makes LCD modules that are used in various industrial displays. Its alphanumeric models range in capacity from 1×16 to 4×40 characters. Featuring blue characters on a white background, these modules have high contrast and a wide viewing angle.

Sharp Electronics Corp makes several large-area LCDs. Their dot-matrix monochrome types include formats of 640×400, 640×480, and 720×400 dots. The viewing areas of these displays are 8.589×5.476 in., 9.338×7.09 in., and 10.24×5.79 in., respectively. All are double-supertwist types that offer high contrast. The 640×480-dot display is particularly well suited for use with the IBM VGA graphics standard. Sharp recently introduced a small-area (3-in. diagonal) color display with a 384×240-dot format that uses active-matrix TFT technology.

LC film can be colorful

Although most manufacturers are still developing color technology for large-area displays with expanded information content, Taliq Corporation is already providing some solutions to the need for color in limited information content applications. Based on a technology it calls nematic curvilinear-aligned phase, Taliq makes plastic liquid-crystal film that's used in its custom Varilite color displays. By combining layers of light-controlling liquid-crystal thin film with graphic

overlays, color reflectors, and membrane switches, Taliq manufactures fully integrated front-panel assemblies that are useful in automotive, industrial, medical, office-automation, and home-appliance applications.

Taliq sells sheets of liquid-crystal film as well as complete custom displays. A sheet of 12 numeric (7-segment), or alphanumeric (16-segment) characters costs \$19.50 for 1-in.-high characters and \$27.30 for 2-in.-high characters. You can order the film in red, green, blue, yellow, or orange. The film has die-cut adhesive on both sides. A typical prototype order for a custom display costs \$3000 to \$5000 and includes all engineering and art-work charges, and 5 to 10 samples. Pricing for large quantities depends heavily on the actual display; a typical automotive tachometer display, for example, might cost \$6 at the 25,000-piece level.

The bright blue-green color of a VF display is eye pleasing and it's undoubtedly a major factor in VFDs' popularity. Although usually limited to small-area displays with limited information content, VFDs are widely used in automobiles, medical equipment, industrial controllers, and point-of-sale terminals. At least one company offers a VF display that combines expanded information content with a display area large enough to make it suitable for both text and graphics.

VF display features touchscreen

Industrial Electronic Engineers (IEE) makes a variety of VFD modules (they also make EL and plasma displays). The IEE model 4283-01, for example, is one of a family of display modules that uses VF technology to good advantage. The module integrates a 6-line by 40-character VF display with an infrared touchscreen. Each of the display's 240 characters is formed by a 5×7-dot matrix that is 0.197-in. high. The module has

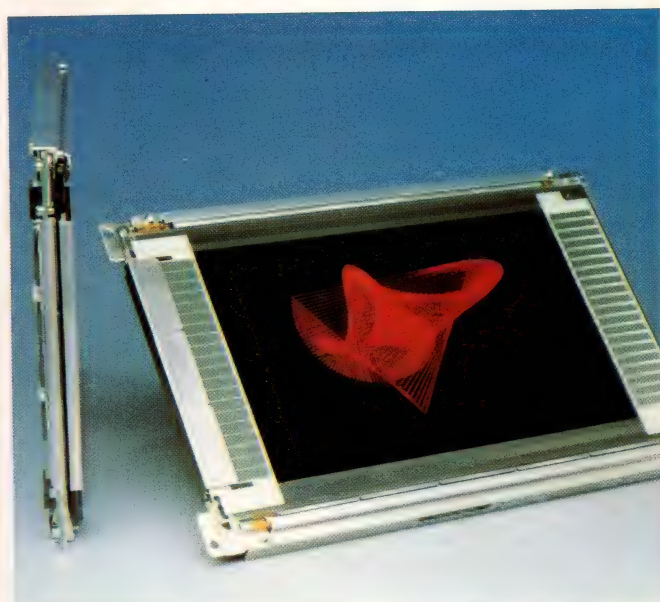


This interactive touch-entry display module from IEE integrates a 6-line by 40-character VF display with an infrared touchscreen.

three software-controlled brightness levels ranging as high as 185 fL. In addition, a wide spectrum of colored filters is available for particular applications. These display characteristics, combined with the touchscreen, make the 4283-01 suitable for a variety of menu-driven applications.

Unlike resistive-membrane and capacitive touchscreens, the infrared type used in the 4283-01 uses no overlays that could obscure the display in any way. The module provides for 969 active switch locations and is immune from false triggering by ambient light—even direct sunlight. You can use this display module to store and retrieve as many as 127 user-programmable messages by means of its 8k bytes of CMOS RAM. A battery-backup circuit retains the messages in the event of power failure. The module operates from a single 5V supply; an onboard μ P controls all display and touchscreen operations, a diagnostic test program, and the serial data interface with the host computer. Prices for the 4283-01 start at \$800 (100).

Futaba Corporation is also pushing the application boundaries for VF displays into previously uncharted areas. The Futaba GP1019A03A uses a high-resolution display technology that allows a pixel pitch of 0.0074×0.01 in. (0.1875×0.225 mm). This VFD module has a pixel count of 640×400 in a display area of 4.72×3.54 in. Its luminous display is a distinctive green



Featuring a distinctive orange color, this plasma panel from Fujitsu provides a high-resolution 640×400 -dot display and a 10-in. (diagonal) viewing area.

The VF display's bright, green-colored display is easily visible.

color, whose wavelength is about 500 nm (you can modify this color by the use of filters). The luminance of the display is moderately high—40 fL (140 cd/m²). It operates from supply voltages of 5 and 135V dc. You connect the display module to the host system via the horizontal sync, vertical sync, and data (RGB) signals. By combining any two of the R, G and B inputs, you can produce a halftone display. Using a liquid-crystal color shutter (Sony-Tektronix 7-in. LCCS) provides a display in three colors, which tend to be combinations of orange and green. The GP1019A03A VFD module costs \$795 in lots of 100 pieces.

Although large-area plasma displays bear little physical resemblance to the Burrough's Nixie tube, the basic operating principle is the same. The Nixie tube, popular in the early sixties, contained a series of electrodes

in the shape of numerals (0 to 9) and a neon gas mixture. Later in that decade, Beckman and Sperry introduced segmented displays that included multiple digits and alphanumeric capabilities in a single glass envelope. The same visible glow (typically orange-red) emanates from today's plasma displays (PDPs). In all cases, the glow results from the ionization of a neon gas. The gas discharge, or ionization, occurs when electrodes within the gas are subjected to a minimum threshold voltage.

PDPs come in a wide variety of shapes and sizes, ranging from small alphanumeric and bar-graph displays to large-area displays suitable for text and graphics in computer and video terminal applications. Companies such as Cherry Electrical Products, Dale Electronics, Dixy Corporation (Fuji Electronics),

A guide to flat-panel displays

Flat-panel displays have a long way to go before they supplant cathode-ray tubes. CRTs, which are one of the last strongholds of vacuum-tube technology, still account for nearly 70% of the estimated \$9 billion electronic display market. They are inexpensive when compared with other technologies, and they have the best resolution and color capability. What's more, they're widely available. The CRT screen is also equal, or superior, to other displays in terms of brightness, contrast, and general visibility. Their main disadvantages are bulkiness, weight, and high power requirements—factors that are of particular importance for battery-operated and portable equipment. What follows is a list briefly explaining the different flat-panel technologies that may someday replace CRTs in most applications.

ELD (electroluminescent display)—ELDs depend on the

properties of substances such as Zn doped with Mn to luminesce when subjected to a high voltage. The higher the voltage, the brighter the luminance. This effect also can generate gray-scale images. A dot-matrix ELD panel consists of column electrodes behind a layer of luminescent material, with transparent row electrodes in front of the material. ELDs offer high resolution and exhibit a yellow-on-black display of high contrast that is pleasing to the eye. This type of flat panel is useful for applications that require both large-area displays and expanded information content, such as portable computers.

There are two basic types of ELDs: ac thin-film (ACTFEL) and dc thick-film (DCTFEL). Although both types can produce the same levels of light intensity, contrast, and resolution, manufacturers of each type claim certain cost or performance advantages. In the past, both

types have shown signs of wearing out earlier than CRT counterparts, whose half-life is typically 10,000 hours. New materials and processing techniques, and the use of electronic circuitry, however, have largely eliminated these premature effects of extended use. ACTFEL displays, for example, used to show latent images on the screen as they got older, but symmetric driving circuits have overcome this problem.

LCD (liquid-crystal display)—In a twisted-nematic LCD display (TNLCD), a liquid-crystal mixture is sandwiched between two glass plates that are coated with a polarizer and lined with transparent electrodes. The application of an electric field shifts the nematic molecules so that they line up with the field, and so changes the molecules' optical characteristics. The refractive index of these molecules depends on their orientation relative to the direction of the incident

Fujitsu Components, Interstate Electronics Corp (IEC), Industrial Electronic Engineers (IEE), and NEC Electronics, all make plasma displays. AC-memory, ac-refresh, and dc-refresh are the three principal plasma-display technologies in use at this time (see box, "A guide to flat-panel displays").

Dale Electronics, for example, makes bar-graph plasma displays that use multiple segments to create a 10-in.-high single-bar model (PBG-C7005), and a 7.78-in.-high dual-bar model (PBG-C7008) that sell for \$55 and \$48, respectively (100). They also make a full-field, dot-matrix graphic display (APD-192G088-1) that has 192 columns and 88 rows. This display includes all drive electronics and a μ P-based controller. Designed for use in computer terminals and other systems requiring a self-contained readout, the display is programmable to

Text continued on pg 146



An IBM PC portable demonstrates the use of Alphasil's active-matrix LCD. The portable system provides a way for OEMs to demonstrate their own applications before investing in a custom or semicustom display.

light. In a standard LCD panel, the application of an appropriate (low) voltage aligns the crystals so that they either transmit or block the polarized light. A dichroic dye included in the crystal material colors the light that passes through it.

LCDs are quite inexpensive, consume very little power, and are thin, durable, and lightweight. Their major disadvantages are poor contrast, low brightness, and a reduction in performance as display size increases. The newer active-matrix types overcome some of these disadvantages but, because each pixel requires a separate drive transistor, the display and the drive circuitry are more complicated—and expensive—than conventional types. Backlighting of LCDs is becoming common for applications where the ambient light level is low.

PDP (plasma display panel)—All plasma displays contain a gas, usually neon, that glows

when subjected to a high voltage. In a dot-matrix display, this voltage is applied between two sets of electrodes; one set runs vertically, the other runs horizontally; the gas is in between the two. Plasma displays exhibit a characteristic orange or red-orange color.

There are three basic plasma technologies: dc-refresh, ac-refresh, and ac-memory. The basic difference between the refresh types and ac-memory plasma displays is that the memory display includes dielectric layers: AC-memory displays have dielectric layers that separate the gas from the activating electrodes. The dielectric in an ac-memory display restricts the electrodes to capacitive coupling with the gas, a condition that allows the gas to stay lit until another signal turns it off. This action serves to create a kind of pixel memory, which eliminates the need for screen refresh in ac-memory plasma displays. Both

the ac- and dc-refresh types require refreshing at least once every 1/60 of a second to prevent flickering.

VFD (vacuum-fluorescent display)—VF displays are well suited for applications that need only limited information content, such as dashboard displays in cars. For displays of less than about 200 characters, this type offers the best cost/character ratio. VFDs have a pleasant blue-green color that is usually brighter than either PDPs or ELDs. VFDs use essentially the same operating principle as a triode vacuum tube: The phosphor-coated anode segments radiate light when struck by electrons emitted by the filament cathode, and a metal-mesh grid controls the flow of electrons from the cathode to the anode. Phosphor alignment problems for high-end applications tend to reduce production yields.

A glossary of display terms

Acuity—The uniformity of light emission across a pixel and its degree of edge definition. Assuming the contrast ratio is high enough for easy distinction of off- and on-pixels, the uniformity of emission of the on-pixels, together with the size and shape of the pixels themselves, dictates the sharpness of the images.

Aspect ratio—The ratio of the display's width to its height. The aspect ratio of the typical TV screen or IBM monitor is 4:3. Flat-panel displays come in a variety of aspect ratios, depending on the particular application.

Birefringence—Double refraction. The splitting of a light beam into two light waves when the beam enters a crystal. The resultant two light waves vibrate in directions that are perpendicular to each other.

Brightness—The light-intensity, or luminosity, of the display. Brightness is measured in foot lamberts (fL), or in candelas per meter squared (cd/m^2). Note: $1 \text{ cd}/\text{m}^2 = 0.292 \text{ fL}$.

CGA—Color-graphics adapter. An electronic display standard that specifies a resolution of 640×200 pixels in the 2-color mode, and 320×200 pixels in the 4-color mode (from a palette of 16 colors). The horizontal scanning frequency is specified as 15.75 kHz.

Contrast Ratio—The ratio of on-pixel brightness compared to the off-pixel brightness. It represents the difference in light intensity between the foreground

and background of a display. Black and white provide the ideal contrast. Depending on the type of display, contrast ratios for flat-panel displays vary from a value of less than 3:1 for some LCD types, to values of 20:1 or more for some ELD types. The perceived contrast depends on the ambient light, but a contrast of about 7:1 is generally considered as an acceptable ratio. Above a ratio of about 15:1, the human eye perceives little difference in contrast.

Controller—A pc board that goes behind the display (or in the computer bus). The controller lets the computer communicate with the display. For a CRT raster-scan display, the controller provides the signals needed for horizontal sync, vertical sync, and serial data. Flat-panel displays usually require an additional signal—the dot-clock signal—to control the transfer speed of the pixel information.

CRT—Cathode-ray tube—An electron tube used in TV receivers, oscilloscopes, radar equipment, and computer equipment to display data. Usually rectangular with a 4:3 aspect ratio, CRTs' diagonal measurement ranges generally from about 5 to 28 in. The diagonal of CRT monitors for computers or video terminals are typically between 12 and 14 in.

Display size—The illuminated area of the display that is available for viewing data. Manufacturers of CRTs usually measure them according to their *diagonal*

sizes. For flat-panel displays, manufacturers usually specify the height and width.

Dithering—A computer-graphics technique used to provide shading by turning points on a pixel on and off. In monochrome plasma displays, for example, each pixel can consist of a cluster of four points (sub-pixels), each of which can be on or off. By turning these sub-pixels on in various combinations, the plasma display can show four levels of brightness, or gray-scale shading.

Dot—See **Pixel**.

Dot-clock signal—The signal that controls the pixel rate for the display system. Digital technologies, such as flat-panel displays, require this signal to tell the host system how fast to read the individual pixel information from the system to the panel. This signal is not required for CRT analog displays.

Duty cycle—Response time. The amount of time it takes for an electronic display to refresh every pixel on the screen. The maximum acceptable time is about 16.6 msec, which corresponds to a minimum refresh rate of 60 Hz. At refresh rates slower than about 60 Hz, the human eye begins to detect a flicker in the display.

EGA—Enhanced-graphics adapter. An electronic display standard that specifies a resolution of 640×350 pixels with 16-color capability (from a palette of 64 colors). Included in this standard are 80- and 40-column

text modes, and CGA emulation.

ELD—Electroluminescent display.

Fill factor—The percentage of the total area of the display that is illuminated at any given time, compared with the surrounding nonilluminated area. Displays with a low fill factor (20%) tend to look like a collection of dots. Displays with fill factors of 50% or more exhibit greater apparent brightness and are generally more readable and aesthetically pleasing.

Flat-panel display—An electronic display with a package thickness that is a fraction of the display's height or length. Flat-panel displays include ELD, LCD, LED, PDP, and VFD types (see **box**, "A guide to flat-panel displays," pg 142). Package thickness, which is typically 0.75 to 1.5 in., varies approximately from 0.5 in. to 2.5 in. The pc board containing the electronics sometimes accounts for a significant portion of the total thickness.

LCD—Liquid-crystal display.

LED—Light-emitting diode. A display that uses diodes made of gallium arsenide or gallium arsenide phosphide to emit light when current is supplied.

Nematic—Threadlike—the typical shape of a liquid-crystal molecule.

PDP—Plasma display panel.

Pixel—A picture element. The smallest unit of a video display. In CRT applications, the pixel's color and intensity is coded into an electrical signal for transmis-

sion from the system to the display. For flat-panel displays, "pixels" and "dots" are interchangeable.

Plasma—An ionized gas containing an approximately equal number of positive and negative charges. The gas emits light when subjected to a sufficiently high voltage.

Resolution—A somewhat nebulous term that manufacturers of flat-panel displays define in different ways. A number of factors determine the real or visually apparent resolution. These factors include the pixel (dot) size and pitch, the number of lines per inch, and the total number of pixels. Although the type of display (ELD, LCD, PDP) can have a significant effect on the apparent resolution because of differences in contrast and brightness, the best quantitative measurement is probably the total pixel count in a given area.

Sparkling—A computer-graphics technique that turns off a pixel every other time the screen is refreshed. Unlike CRTs, which typically use high-persistence phosphors, flat-panel displays turn off when the power to a pixel is removed. Sparkling can provide a 2-value gray scale that is satisfactory for a monochrome display or the 2-color 640×200-pixel CGA mode. For the 4-color 320×200-pixel CGA mode, flat-panel displays sometimes use dithering to provide a 4-value gray scale.

Super-twist LCD—A liquid-

crystal display that rotates the plane of polarization in the range of 180 to 270° in contrast with a conventional twisted-nematic LCD, which imposes only a 90° twist on the plane of polarized light passing through the display. In addition, an alignment layer in the display provides a pre-tilt of from 10 to 30°. The pre-tilt and increased twist give super-twist LCDs contrast ratios of about 10:1 and viewing angles as high as 60°.

Twisted-nematic LCD—Also, TN-LCD. A display in which the liquid-crystal material imposes a 90° rotation (twist) on the plane of polarized light passing through the display. Conventional TN-LCDs have contrast ratios of less than 3:1 when viewed head on, and exhibit viewing angles of less than 40°.

VGA—Video-graphics array. An electronic display standard that specifies a resolution of 640×480 pixels with 16-color capability, and 320×200-pixel resolution with 256-color capability (from a palette of 256k colors). The array's functions are available on an add-in board as an adapter.

Viewing angle—The range of angles at which you can read a display, measured in angular degrees of distance from the perpendicular. A viewing angle of 120°, for example, lets you read the display at any angle from 0 to 60° from a plane that is perpendicular to the surface of the display. A conical viewing angle lets you read from above, below, or either side of the display.

The ubiquitous orange-colored plasma display is used in a wide range of applications from gas-station pumps to personal computers.

operate in a serial or parallel mode, and contains all the necessary refresh memory, character generation, and control logic. A 4k×8-bit EPROM generates 256 characters consisting of 128 ASCII characters and 128 block graphics characters. The viewing area of the \$699 (100) display is 7.66-in. wide by 3.5-in. high.

Plasma display uses PWM

Dixy Corporation makes a plasma graphics display (D0640AX) that has a light intensity of 35 fL, which is about 20% brighter than its earlier models. The viewing area of the display is 10.086×6.30 in., the viewing angle is 115°, and the resolution is 640×400 pixels. Using pulse-width modulation, the D0640AX provides 16 gray-scale levels. The scan frequencies for this orange neon display are 21.0526 MHz (dot clock), 24.8262 kHz (horizontal sync), and 56.4334 Hz (vertical sync). You can adjust the display for dot-clock phase, horizontal location, vertical location, brightness, and signal polarity. Samples cost \$1950 each.

Although most suppliers of plasma displays that use ac-memory technology sell exclusively to the military, Fujitsu Components also sells its products commercially. According to Fujitsu, ac-memory displays offer three major advantages compared to other plasma-display technologies: Continuous pixel illumination provides a high resolution. A steady brightness eliminates the flickering that screen refreshing can sometimes cause. And the displays have a higher reliability rate (the company specifies an MTBF rate of 50,000 hours).

Fujitsu's FPF-8050-HFUG module features a

640×400-dot viewing area of 8.3×5.2 in. (10-in. diagonal). The display's 0.008-in. (0.2-mm) pixels are arranged in a 0.013×0.013-in. (0.33×0.33 mm) dot pitch. The assembled display, including drive circuitry mounted to the back of the panel, is just over 1-in. thick. The use of 64-bit LSI drivers reduces power consumption to 35W at 100% illumination. This orange-on-black display has a character brightness of 44 fL, a contrast ratio of 20:1, and a viewing angle of 120°. Designed for use in such applications as medical instrumentation and transportable computers, the FPF-8050-HFUG costs \$945 (the cost decreases to between \$400 to \$500 if you buy 5000 units in a year).

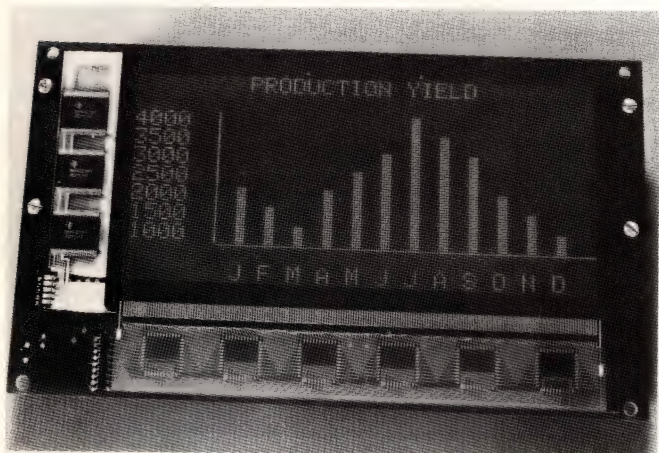
Although electroluminescent displays are not yet a major factor in the total market for flat-panel displays, electroluminescent displays (ELDs) are gaining popularity. For one thing, the characteristically bright, high-contrast, yellow-on-black display is probably more pleasing to the eye than any other type of flat-panel display. What's more, as manufacturers of large-area ELDs succeed in reducing manufacturers costs and power consumption, you can expect to see more of these attractive displays in such applications as computer terminals and transportable computers.

The Seal-Touch Terminal from Digital Electronics Corp is a \$3950 ELD that's suitable for the shop floor. Its 9-in. (diagonal) panel features an infrared touch-screen in a completely sealed cast aluminum case. The package is lightweight and compact—it measures 10.5×11.5×3-in.—so you can mount it on a bench, a wall, or other equipment. The Seal-Touch unit emulates VT-52, VT-100, and VT-220 terminals. It has an 80×25-character format, line graphics, downloadable fonts, pop-up touch menus, and onscreen touch keypads. An auxiliary port lets you use the unit with an attachable keyboard. The terminal supports RS-232C, RS-422, or RS-485 interfaces.

ELDs overcome their drawbacks

Despite the fact that EL displays are aesthetically appealing, they have not yet been widely accepted because, relatively speaking, they have cost a lot and they haven't lasted very long. But these barriers to their success are disappearing as manufacturing implements new processing techniques and materials as well as new driving schemes.

Stand-alone ELDs are available from several companies. Finlux Inc (Lohja Corp), Planar Systems, and Sharp Electronics make ac thin-film (ACTFEL) displays; Cherry Electrical Products makes dc thick-film



Dot-matrix plasma displays are useful for charting graphic data. This 192-column by 88-row panel from Dale Electronics is used in computer terminals and other systems that require self-contained readouts.

"EDN MAGAZINE GREATLY ENHANCES OUR INTERNATIONAL IMAGE."

Phil F. Walters
Marketing Director
Hunting Hivolt Ltd.

Based in England, Hunting Hivolt is a leader in high-voltage technology. Yet the company wanted to further enhance its international image and gain an even greater awareness with engineers and engineering managers worldwide.

What was the answer?

First, set up a facility in the United States. Then support it with an advertising program in EDN magazine. Says marketing director Phil Walters, "The result has been an utter success. The quality of response has helped strengthen our position in

the United States and throughout the many countries where EDN magazine is circulated."

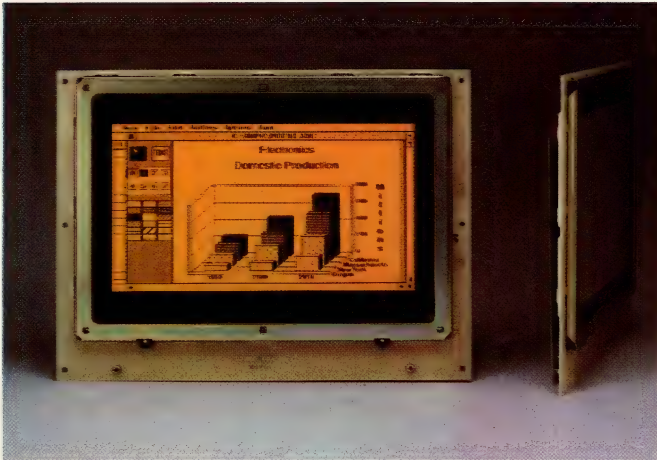
Phil Walters sees EDN magazine as a key element in his worldwide advertising campaign. "With EDN magazine and the solid foundation of Cahners Publishing behind it, we will continue to make strides in the international marketplace."



Advertising in EDN magazine works for
Hunting Hivolt. It can work for you.

EDN

Where Advertising Works



This EGA-compatible EL display, the EL8358HR, is suitable for MS-DOS-based text and graphics applications. The Planar Systems display has a resolution of 640×400 pixels and a viewing area of 5×8 in. The high-contrast module has a 30-fL pixel brightness.



Featuring a light intensity of 35 fL and a resolution of 640×400 pixels, this Dixy plasma display panel has a viewing area of 256×160 mm.

(DCTFEL) modules. Finlux Inc, for example, now uses a thin-film deposition process, which it calls atomic-layer epitaxy. The process gives the ZnS active layer more uniformity. According to the company, this process not only enhances the overall performance of the display, but also improves manufacturing yields and lengthens the operating life of the product.

Finlux makes ELDs with pixel counts from 320×256 to 640×400 at prices from \$590 to \$730 (100). All of the company's displays have yellow foregrounds with a 520-nm wavelength. Their emission spectrum is 60-nm wide. A typical pixel luminance is 26 fL (90 cd/m²); the displays' contrast ratio is greater than 10:1.

Finlux's MD640.400 display has a screen resolution of 640×400 pixels, which lets you display high-resolution graphics of 25 lines of text at 80 characters per line. This display includes a display-driver board that features a digital interface consisting of four TTL-level signals: video data, video clock, horizontal sync, and vertical sync.

EL display features dc/dc converter

The MD640.400 has a viewing area of 4.806×7.68 in. and scans at a refresh rate of 60 Hz. The screen has a matrix of 0.009-in. (0.22-mm) square pixels on a 0.012-in. (0.3-mm) pitch, which is equivalent to about 83 pixels/in. Its viewing angle is 140°. The display comes with a dc/dc converter that you can either use remotely or mount at the rear of the assembly. The converter, which operates on dc inputs of 5V and 12 to 15V, consumes about 16W of power. Finlux is actively work-

ing on the development of large-area EL multicolor displays, but production of these types is several years away. Gray-scale displays will be available in several sizes next year.

Planar Systems, a major supplier of ACTFEL displays, has several models of various sizes and pixel counts in its product line. Most notable is its EL8358HR, a display with a high-resolution (640×400-pixel) viewing area of about 5×8 in. It's EGA compatible and suitable for use with MS-DOS-based text and graphics. The EL8358HR is priced at \$675 (1000), including the power supply.

Planar has recently upgraded all of its ELDs, including the EL8358HR. Pixel brightness for that model is now 30 fL (compared to the previous 20 fL), and maximum peak power consumption is down from 25W to between 14 and 16W (the typical average is 10W). Like Finlux, Planar uses square pixels that are 0.0087 in. (0.22 mm) on each side and have a 0.012-in. (0.3 mm) pitch, which gives the display a density of 83 pixels/in.

When you use the circular-polarizing filter that comes standard with the EL8358HR, you get a contrast ratio of 60:1. The filter doesn't enhance the contrast; rather it reduces any glare or reflection that might affect your view of the panel. As is customary, Planar defines contrast as the ratio of light intensity between the on-pixel and the off-pixel (see **box**, "A glossary of display terms"). The contrast ratio for the EL8358HR 30 to 0.2 fL, or 150:1 (the filter reduces this ratio to 60:1). One might argue that a contrast ratio of 60:1 is superfluous, but Planar points out that, in

Make it friendly. Touch it.



Design a system that gives you a competitive edge. Make it simple to use. Easy to learn. Make it friendly. With a touch input system from Carroll Touch, the world's leading OEM supplier of touch products.

Discover the full line of solutions Carroll Touch offers. From infrared to overlay touch products. Select from a wide range of standard add-on units in a variety of sizes. Or from a line of fully integrated computer displays equipped with touch. Or specify your own unique requirements.

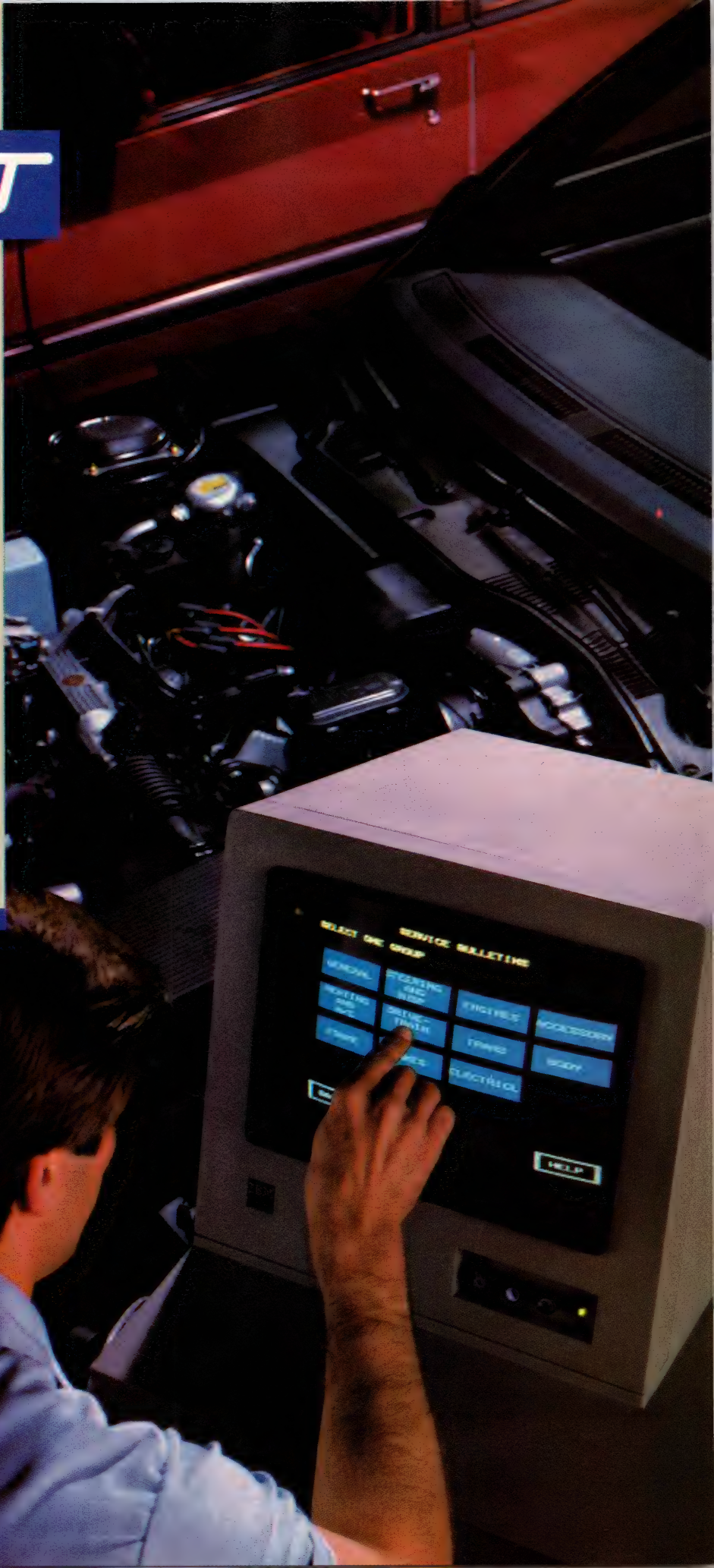
Once you've chosen the Carroll Touch product that's right for your system, you'll discover even more. Exceptional quality and ruggedness. High reliability. Low maintenance. Making touch more affordable and cost-effective than ever.

Whether it's sophisticated test equipment for automotive technicians. Or a medical diagnostic system for patient care. Make your next system friendly. Touch it. Begin by calling 512/244-3500.

Carroll Touch

a subsidiary of AMP Incorporated

P.O. Box 1309
Round Rock, Texas 78680
512/244-3500 Telex 881906
CIRCLE NO 100



EL displays are gaining in popularity; their high-contrast, yellow-on-black color is aesthetically pleasing.

situations where the display is viewed briefly from a distance, this high ratio is advantageous. The company does agree, however, that for constant close-up viewing of equipment like computer screens, you might want to lower this ratio by reducing the brightness of the display.

Planar has developed an RGB color display for use in military applications and is working on reducing the costs of the materials and manufacturing process so that the display will be commercially viable. It expects to be able to produce economical commercial displays in about two years.

It's important to get the right RGB balance

One technical problem with RGB displays involves obtaining both chromaticity and intensity values that strike the right balance of red, green, and blue. This balance is important in order to accommodate the varying sensitivity of the human eye to different wavelengths of color. The display's luminescent material is the key to the light intensity of these colors, and chemistry plays a dominant role in achieving the proper balance. Monochrome EL displays typically use Mn-

doped ZnS to produce their characteristic yellow color, but the color blue, for example, requires Ce-doped SrS. To obtain the red and green colors for an RGB display, manufacturers use the same ZnS used for a monochrome display, but the doping agents are more exotic chemicals than Mn. Another problem in the making of RGB displays is that you need more pixels for any given area. For example, a 640×480 -pixel monochrome display translates into a 1920×480 -pixel RGB display.

Cherry Electrical Products has been a leading maker of gas-plasma displays for the past 15 years. Now it's starting to be prominent in ELD arena. Cherry uses a dc thick-film approach that it claims offers advantages over the more common ac thin-film types such as simple and rugged construction, the absence of potential thin-film dielectric breakdown, and higher manufacturing yields. Moreover, the Cherry EL displays are very thin; including the electronics board, they measure less than 0.6-in. thick.

Cherry offers two 640×200 -pixel EL displays with a viewing angle of 160° . The EL1C-A000 has an active viewing area of 8.96×3.9 in. The EL1C-B000 has an active viewing area of 7.68×4.8 in. The pixel size and pitch (aspect ratio) differ with the model number. The pixels in the A000 display measure 0.010×0.017 in. and have a pitch of 0.014 in. (horizontal) by 0.020 in.



With its characteristic yellow-on-black color, EL displays provide high contrast. This electroluminescent flat-panel display from Digital Electronics Corp has an infrared touchscreen and is completely sealed in a cast aluminum case for use in harsh environments.

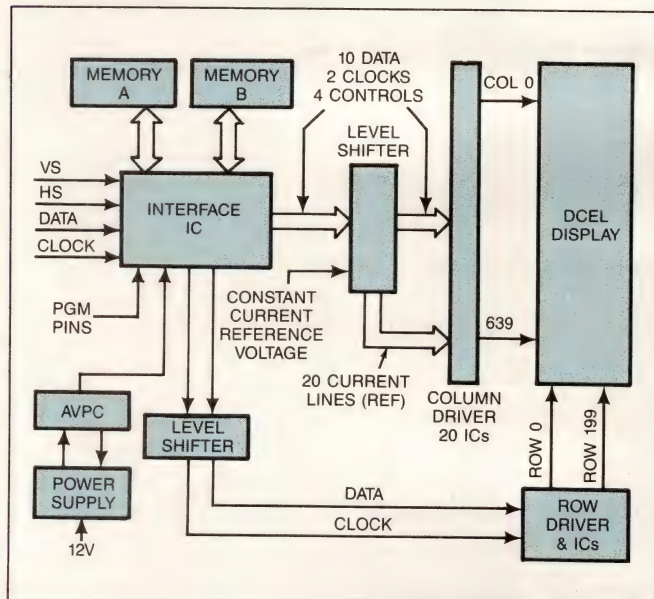


Fig 1—DCTFEL displays require specialized drive circuitry. This circuit works with Cherry's electroluminescent models and provides data and timing signals for the row drivers and constant-current column drivers. Video data with a frame rate of 60 Hz is translated into a 240-Hz frame rate for the column drivers.

EUROCOM D1-IA8 SINGLE-CHIP DELTA CODEC + FILTERS



FX619



Features/Applications

- Designed to Meet Eurocom D1-IA8
- Military Communications
- Delta MUX, Switch and Phone Applications
- Single-Chip Full-Duplex Codec
- On-Chip Input and Output Filters
- Programmable Sampling Clocks
- 3 or 4-bit Compand Algorithm
- Forced Idle Facility
- Powersave Facility
- Single 5V CMOS Process
- Full-Duplex CVSD Codec



Consumer Microcircuits Limited

1 Wheaton Road, Witham, Essex, CM8 3TD ENGLAND.

Telephone: (0376) 513833. Telex: 99382 CMICRO G. Telefax: (0376) 518247.

Plasma displays are often combined with infrared touchscreen panels for use in industrial control applications.

(vertical); its aspect ratio is 1.4:1. In the B000 display, the pixels measure 0.008×0.0202 in. and have a pitch of 0.012-in. horizontal by 0.024-in. vertical; its aspect ratio is 2:1. Pixel luminance is nominally between 20 and 25 fL, and Cherry specifies less than 30% degradation in brightness over 10,000 hours. Both models sell for \$565 (100) (\$250 in OEM quantities).

AC thin-film vs dc thick-film displays

Although there are numerous small differences between ac thin-film (ACTFEL) and dc thick-film (DCTFEL) displays, the major difference involves the operation of the two types of displays. An ac thin-film display is capacitive in nature and its brightness is limited by drive voltage and by pulse-repetition frequency. A dc thick-film display is resistive in nature and its brightness is proportional to its constant drive current. Cherry spent several years developing its dc thick-film displays, and their successful operation owes nearly as much to their electronics drive circuitry as it does to their basic construction.

The Cherry drive circuitry (Fig 1) uses some custom and standard ICs from Siliconix and Texas Instruments. The interface IC provides data and timing signals for the constant-current column drivers, row drivers, and control signals. The frame rate for incoming video data is 60 Hz; for data output to the column

drivers, it's 240 Hz. The higher frame rate for the column drivers provides a brighter display with less power consumption, thus lengthening the life of the EL display.

Four TTL signals—vertical sync, horizontal sync, data, and clock—control the circuit operation. The level-shifter IC converts the 5V CMOS-logic outputs of the interface IC to 12V signal levels needed for the column drivers. It also converts a 0 to 12V analog reference to a constant current capable of driving 20 column drivers. The column-driver IC provides a controlled capacitive charging current, and an illuminating current with a programmable range from 100 μ A to 1 mA. The row-driver IC sinks a minimum of 200 mA when on. The power supply operates from a single 12V input. An automatic voltage- and pulse-control circuit adjusts the output of the power supply to provide a preset luminance level throughout the life of the panel. Cherry has two excellent papers on the development and construction of its EL displays and the electronic drive circuitry (Refs 1 and 2).

Flat-panel displays employ several different technologies and are available in a range of sizes and shapes. From simple bar graphs to displays large enough for use in computers, you have a wide choice when looking for a display to suit a particular application. LCDs, VFDs, and PDPs will likely continue to dominate

Manufacturers of flat-panel displays

For more information on flat-panel displays, contact the following manufacturers directly, circle the appropriate numbers on the Information Retrieval Service card, or use EDN's Express Request service.

Alphasil Inc
1045 Mission Ct
Fremont, CA 94539
(415) 651-3636
Circle No 650

Cherry Electrical Products
3600 Sunset Ave
Waukegan, IL 60087
(312) 662-9200
Circle No 651

Dale Electronics Inc
2064 12th Ave
Columbus, NE 68601
(402) 564-3131
Circle No 652

Digital Electronics Corp
31047 Genstar Rd
Hayward, CA 94544
(415) 489-3500
Circle No 653

Dixy Corp
24050 Madison St, Suite 102
Torrance, CA 90505
(213) 373-0555
Circle No 654

Finlux Inc
20395 Pacifica Dr
Cupertino, CA 95014
(408) 725-1972
Circle No 655

Fujitsu Components Inc
3320 Scott Blvd
Santa Clara, CA 95054
(408) 562-1000
Circle No 656

Futaba Corp
711 E State Parkway
Schaumburg, IL 60195
(312) 884-1444
Circle No 657

Industrial Electronic Engineers
7740 Lemona Ave
Van Nuys, CA 91409
(818) 787-0311
Circle No 658

Interstate Electronics Corp
1001 E Ball Rd
Anaheim, CA 92803
(714) 758-0500
Circle No 659

NEC Electronics Inc
401 Ellis St
Mountain View, CA 94039
(415) 960-6000
Circle No 660

Panasonic Industrial Co
Two Panasonic Way
Secaucus, NJ 07094
(201) 348-7000
Circle No 661

Planar Systems Inc
1400 NW Compton Drive
Beaverton, OR 97006
(503) 690-1100
Circle No 662

Seiko Instruments
2990 W Lomita Blvd
Torrance, CA 90505
(213) 517-7770
Circle No 663

Sharp Electronics Corp
Sharp Plaza
Mahwah, NJ 07430
(201) 529-8200
Circle No 664

Taliq Corp
1277 Reamwood Ave
Sunnyvale, CA 94089
(408) 745-0750
Circle No 665



1953 was a very good year.

That's when we began making precision snap-action switches. With stainless steel coil springs to give them long life.

We made them very, very good. So engineers came to know . . . and trust . . . the name "Cherry."

In the 60s we added thumbwheel switches, keyboards and printed circuit boards. All very good, too.

The 70s introduced our displays, bar graphs and semiconductors.

The 80s brought forth sub-subminiature switches and voice recognition peripherals for computers.

With the 90s in view, we've created the first DC Flat Panel Electroluminescent Display for portable computers and advanced information & control systems.

All with the Cherry name . . . backed by decades of experience . . . and an industry that's growing with us. Try us. We're very good.



CHERRY ELECTRICAL PRODUCTS

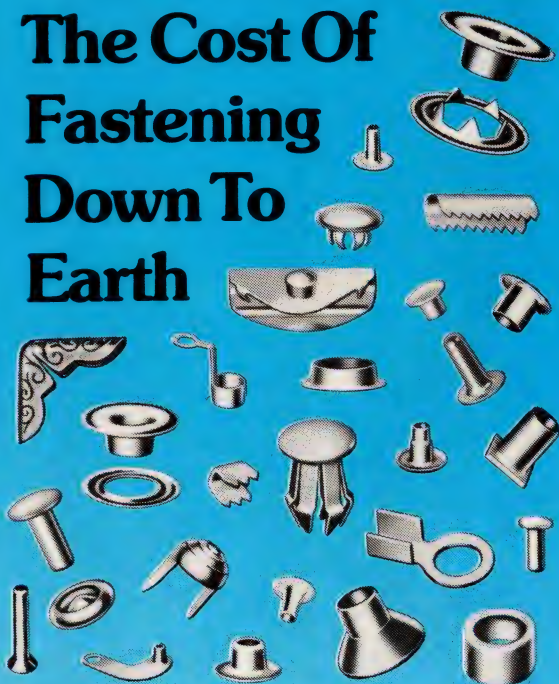
3600 Sunset Avenue, Waukegan, Illinois 60087
312-360-3500 • FAX: 312-360-3566



CIRCLE NO 102

displays • Electronic Components • Switches • Keyboards • Automatic Devices • Electroluminescent Displays • Printed Circuit Boards • Semiconductors

Stimpson Brings The Cost Of Fastening Down To Earth



That's the reason so many designers, buyers and production people responsible for holding down costs while maintaining quality have turned to Stimpson Fasteners and Fastening Machines.

Send a sample of your product, assembled or not. Our Assembly Service experts will analyze and assemble it with the right size, style and finish eyelet or other fastener and recommend the fastening machine best suited to your application ...with substantial savings, just as they've done for years, for so many others. No charge of course.

Send today for your free copy of our latest Designer's Catalog. Illustrating over 1,000 Standard Fasteners and Stampings, plus a full line of automatic attaching machines.



900 SYLVAN AVE. BAYPORT, NY 11705-1097
(516) 472-2000

limited information content applications, while PDPs, ELDs, and active-matrix LCDs strive to satisfy the demands for large-area displays capable of providing expanded information content. As ELDs and active-matrix LCDs come down in price, you can expect to see more of them in more and more demanding applications. These types of displays will also be available in color, probably within the next three years. **EDN**

References

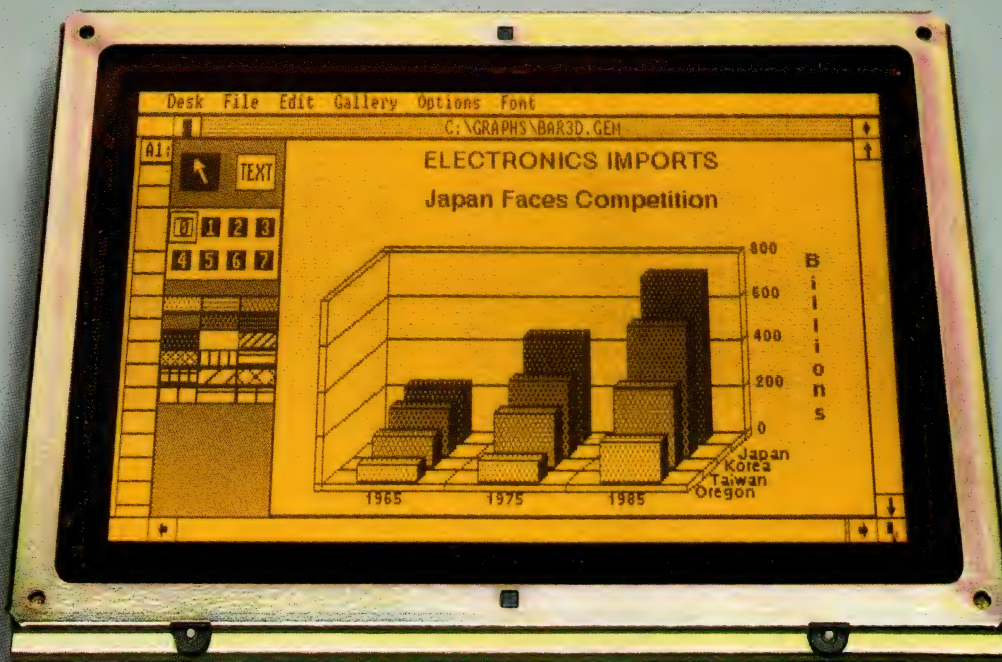
1. Channing, D and L Chiang, "Drive System for a 640×200 dc EL display," Cherry Display Products, Waukegan IL.
2. Glaser, David, and George A Kupsy, "DC electroluminescent 640×200 display panel," Cherry Display Products Corp, El Paso, TX.

Article Interest Quotient (Circle One)
High 470 Medium 471 Low 472

Display technology is often the last thing you specify.



And the first thing your customer sees.



LCD display and Planar EL display photographed under identical ambient lighting conditions.

From a customer's viewpoint, there's only one real window into your product.

The display.

If it's inferior, your product is judged inferior. No matter how good it really is.

For flat panel displays, there's a simple, yet elegant solution. Planar's electroluminescent (EL) display. Why is EL the preferred display technology? Better viewing angle. Better brightness. Better contrast.

It adds up to superior performance.


So contact us today. Choose the flat panel display that surpasses all others from every-one's point of view.

For a brochure, please phone either 503-690-1100 or 503-690-1102, or write to

PLANAR SYSTEMS, INC.

1400 N.W. Compton Drive
Beaverton, Oregon 97006.

PLANAR



"A career as an EDN editor offers you great variety and flexibility."

EDN Editor David Shear

Just over a year ago, David Shear held an engineering position much like yours. Today, as an EDN editor, he is extending his engineering experience.

David is enthusiastic about his new career: "I'm acquiring a broader understanding of engineering than was possible as an engineer and the work is more varied. Also, the writing challenges me to translate my knowledge and experience into useful information for our readers."

He also enjoys the recognition and visibility that come with being an EDN editor. As David says, "I cover developments, breakthroughs, new technologies, and product introductions across the entire spectrum of electronics.

I'm at the forefront."

You too can turn your electrical or electronic engineering background into an exciting opportunity with EDN. All you need are a B.S. in electrical engineering, at least two years of design experience, and an ability to write clearly. Salaries are commensurate with engineering experience.

If you're interested, please call Toll Free 1-800-521-1127 x733 and ask for Michelle Clarke in Human Resources. Or send your resume to her at Human Resources Dept 275 Washington Street, Newton, MA 02158-1630. David Shear is glad he did. You will be too.

EDN

we never stop
asking

What if...

HP humbly introduces
the highest performance
multimeter in the world.



100,000 readings per second and Cal Lab accuracy.

Lots of people claim they have the best multimeter, but we're just going to let the specs do the talking. You'll see we've created a multimeter that doesn't present you with a bunch of trade-offs—you can have speed and accuracy.

- 100,000 readings per second at 4½ digit resolution. If you need 5½ digit resolution, you'll get it at 50,000 readings per second.
- Remarkable throughput rate—change a function and change a range, take

a measurement and output to the bus 200 to 300 times per second.

- Calibration standard accuracy and 8½ digits.

To get complete technical specifications before you order an HP 3458A DMM for your system, contact your local HP sales office.

© 1988 Hewlett-Packard Co. 0901707/EDN

 **HEWLETT
PACKARD**

VF Technology... The Bright Decision

Futaba, a world leading manufacturer of vacuum fluorescent displays, offers a wide assortment of *display tubes* in many sizes and formats. Also, Futaba offers *display modules* with all the electronics required to refresh the display and easily interface with the host system.

GRAPHIC DISPLAY

Both front glass phosphor, which provides maximum viewing angle and uniform surface appearance, and conventional back glass phosphor, with optimum brightness and software dimming capabilities, are available. All Futaba graphics modules offer complete drive electronics, bit mapped control with a DC/DC converter. All active components are surface mounted onto a single board.

DOT MATRIX MODULES

Utilizing Futaba's dot matrix displays, a completely intelligent line of "dot modules" is available. Each includes all drive, power supply and microprocessor components surface mounted onto a single board. Surface mounted technology results in higher reliability and allows for a smaller overall package and lower cost. All dot modules require only a 5V DC power source and can accept parallel or 8 possible serial baud rates.

GRAPHIC DISPLAYS/MODULES

Futaba Display	Futaba Module	Pixels (Row X Char.)	Brightness (FT-L)	Module Dimensions (in.)
GP1005B	GP1005B03	128X64	400	7.28X3.35X1.77
GP1006B	GP1006B04	256X64	200	9.84X3.35X1.77
GP1009B	GP1009B03	240X64	200	6.2X2.76X1.57
GP1010B	GP1010B01	176X16	200	7.32X2.16X1.70
GP1002C	GP1002C02	320X240	100*	7.10X6.30X1.60
GP1004B	GP1004B03	640X400	30	9.65X7.28X1.85

*Different Versions Available

DOT MATRIX DISPLAYS/MODULES

Futaba Display	Futaba Module	Char. X Row	Dot Format	Char. Ht. (in.)	Module Dimensions (in.)
20SD01Z	M20SD01	20X1	5X7	0.200	6.3X1.97X.75
20SD42Z	M20SD42	20X1	5X12	0.344	7.1X2.16X.88
40SD02Z	M40SD02	40X1	5X7	0.200	9.45X2.16X.88
40SD42Z	M40SD42	40X1	5X12	0.344	9.45X2.16X.88
202SD03Z	M202SD03	20X2	5X7	0.200	6.7X2.56X.90
402SD04Z	M402SD04	40X2	5X7	0.200	10.43X2.56X.90

MANY OTHER
DISPLAYS

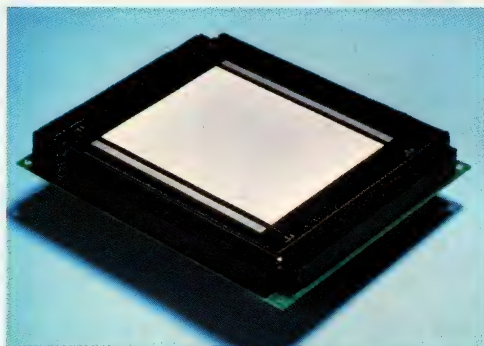
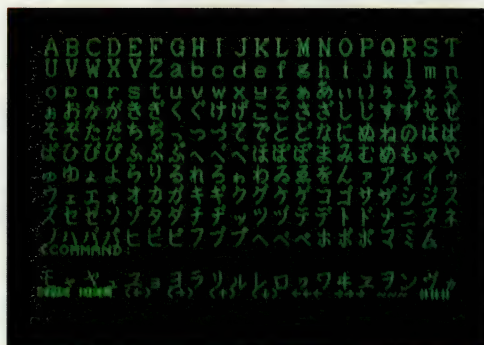
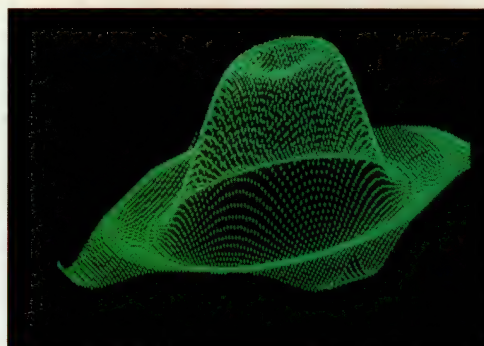
NEW MODULES
AVAILABLE SOON



FUTABA
Corporation of America
Electronic Components Division

711 E. State Parkway
Schaumburg, IL 60173

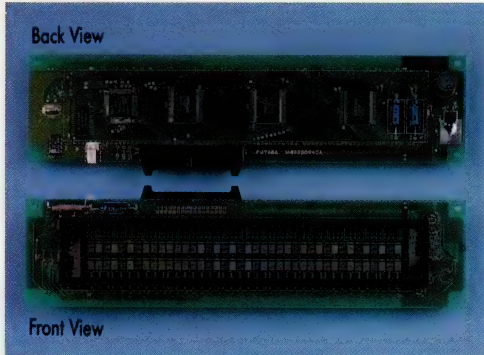
Telephone: (312) 884-1612
or (312) 884-1444



Compact, flat panel graphic displays and modules present clean, sharp images, whether for text or full graphics application.



2 x 40 character (display)



2 x 40 character (module)

Pattern flexibility and pleasing appearance are offered by Futaba in dot displays and modules.



Futaba also offers a complete catalog of alphanumeric, segmented displays.

Futaba supports its products with design engineering and system integration assistance. Call or write today.

"EDN MAGAZINE'S PRODUCT MART SECTION IS HELPING US BECOME A LEADER IN OUR MARKETPLACE."

Raymond J. Schnorr
Vice President of Marketing
ACCEL Technologies

As Vice President of Marketing, Ray Schnorr is responsible for marketing ACCEL Technologies' affordable, professional software that meets the design needs of electrical engineers. He operates on a fixed budget and demands results. "When it comes to buying media, I'm interested in two things: performance and price. With EDN's Product Mart section, I pull high-volume sales leads and meet my budget," says Schnorr.

In nineteen months, ACCEL has sold 5000 software packages to 3000 sites. "Our 1/9-page Product Mart ads in EDN magazine are allowing us to reach our target audience." And Schnorr sees more for EDN and ACCEL. "We have significant growth plans for ACCEL, and running bigger ads in EDN will be part of the strategy to get there.

"The power and prestige of EDN is helping us grow into a leading design software company."



Great Designs Start With Tango-Schematic. Just \$495.
Design quickly come to life with Tango-Schematic's easy-to-use drawing editor and extensive component libraries. Features four line types, four text sizes, repeat and block functions, unique built-in word processor. Includes DRG, ROM, Wire List, Net List outputs and crisp plots, prints, or laserprint. The perfect front end to our popular Tango-PCB and Tango-Route board design systems.
For IBM PC/XT/AT/PS/2, just \$495. Full Function Demo Package. \$10. Order toll-free 800-455-7801. VISA/MC. Thirty-day money back guarantee.
ACCEL Technologies, 7358 Trade St., San Diego, CA 92121 (Outside U.S. America contact ISS Technology, Australia) Phone: 61-62-34-4949. FAX: 61-62-34-4771.
CIRCLE NO 347

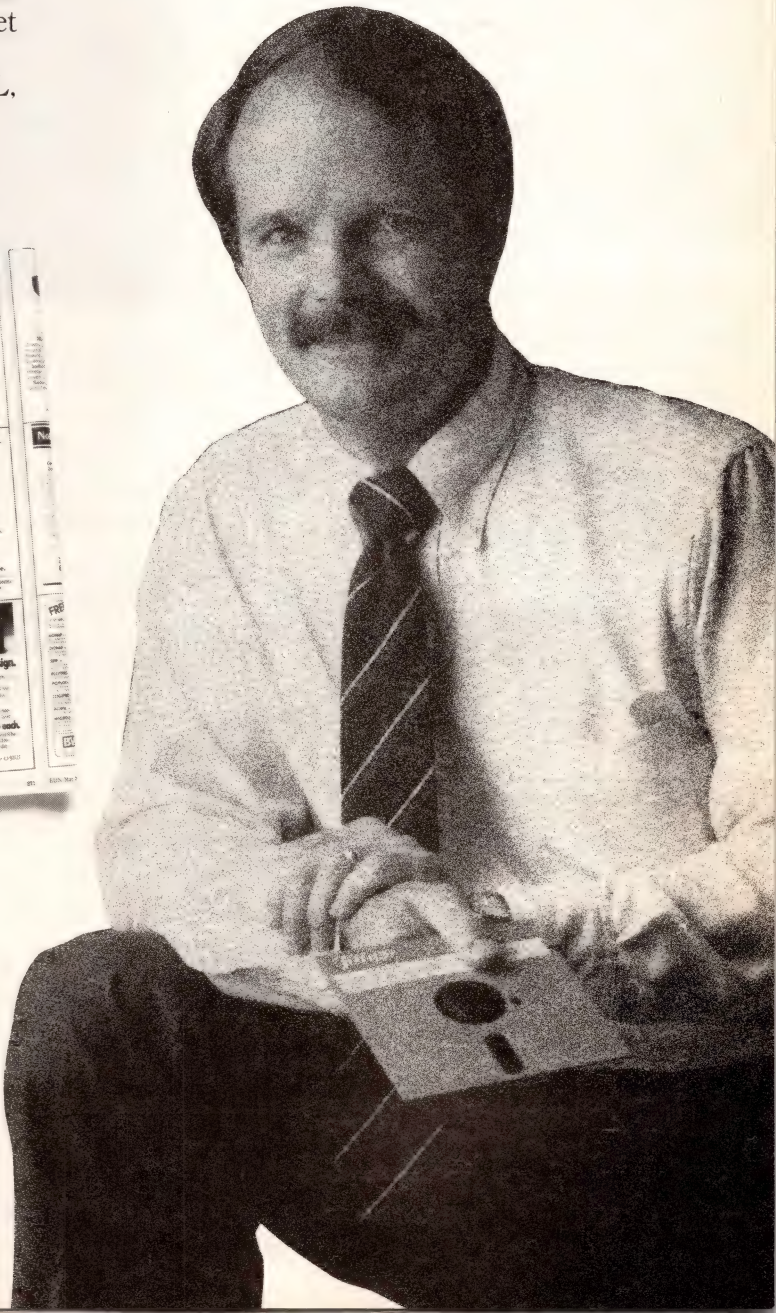
Glide Through PCB Design. TangoPCB. Create the toughest board designs with powerful layout software that's a snap to use. Functions-rich Tango-PCB supports eight layers, 1 mil grid, OrCAD or Schema netlist input, print/plot/photocopy output, and more.
TangoRoute. Get impressive completion rates and remarkable speed with Tango-Route, a four layer, eleven pass autorouter. **Just \$495 each.**
For IBM PC/XT/AT/PS/2. Complete features and your 11 day Tango. Or try full-function Demo Package, just \$10. Order toll-free 800-455-7801. VISA/MC. Thirty-day money back guarantee.
ACCEL Technologies, 7358 Trade St., San Diego, CA 92121
CIRCLE NO 348

PCB 'REPAIRABLE' IC'S - QUARTZ ACCELEROMETERS
SOLVE DEBUGGING PROBLEMS
MINIPOINT A FULL RANGE OF CONNECTORS & SOCKETS
GANG/SET (EEPROM) MULTIPROGRAMMERS
SWITCH
EMULATION Technology, Ltd.
Glide Through PCB Design. TangoPCB
TangoRoute
CIRCLE NO 349

EDN magazine works for
ACCEL Technologies. It can work for you.

EDN

Where Advertising Works



Introducing OrCAD Verification and Simulation Tools

Logic Simulation

Easy to use menu driven commands speed and simplify design verification.

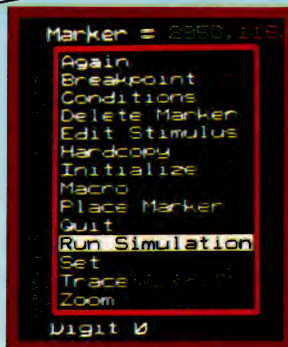
OrCAD / VST The Next Logical Step

Introducing OrCAD / VST, a full featured verification and simulation tool that is designed to place the performance of an expensive workstation on your PC.

OrCAD / VST is integrated with the popular OrCAD / SDT schematic capture package, with easy-to-use menus and powerful keyboard macros. Your valuable time is used to simulate designs without investing the time, money and resources to built prototypes.

With unsurpassed performance on a PC, you'll discover that nothing comes close to OrCAD's features and price. Benchmark the specifications for yourself. We guarantee satisfaction, or your money back!

- Event driven, 12-state functional simulator
- Exceeds 10,000 events/sec. on an 8 MHz AT without additional hardware
- Over 14,000 gate capacity



- Logic analyzer display format. Virtual screen displays 50 channels
- 10 breakpoints can be set as AND/OR condition of up to 16 signals
- User selectable minimum and maximum delays
- Input stimulus is easily defined with an integrated pop-up editor
- Includes component models of TTL, ECL, CMOS, Memory devices, and easy to use utility for creating custom models

- Of course, OrCAD's excellent support: technical staff to answer questions, 1 year of free product updates, and a trained sales and support network

Call or write today for our Demo Disk and brochure.

OrCAD™
Systems Corporation

1049 S.W. BASELINE ST. SUITE 500
HILLSBORO, OREGON 97123, USA

503-640-9488

Contact your local OrCAD Representative for further information

AUSTRALIA
Prometheus
03819 6088

AUSTRIA
Dahms Elektronik GmbH
0316-640300

DENMARK
Supersoft
817-3065

OR 8746-A

ENGLAND
ARS Microsystems, Ltd.
(0276) 685005

FINLAND
Elektrotel OY
754-3122

FRANCE
ALS Design
(04) 6043047

ITALY
BRM Italiana
(011) 287884

JAPAN
Sotec Company, Ltd.
045 (641) 0802

BENELUX
Post Electronics, NL
02159 - 41774

SPAIN
Next-Fors
(0) 261-2415

SWEDEN
Technology Partners
08-156815

SWITZERLAND
Logmatic AG
056 83 38 38

WEST GERMANY
Compware GmbH
040 - 818074

CIRCLE NO 110



Simulation helps you design radiation-hard circuits

You no longer need to use guesswork, rules of thumb, or prohibitively expensive test protocols to predict the effects of manmade and naturally occurring radiation on spaceborne electronic assemblies. Circuit simulation can help you develop radiation-hardened designs quickly and economically.

Kevin Walsh, *Electrical Engineering Software*
and Gary Lum, PhD, *Lockheed Missiles and Space Co*

To ensure the reliable operation of spaceborne electronic systems, you must consider radiation effects such as single-event upset (SEU), a condition that can bring on system failure. Circuit-simulation software can help you predict the effects of SEU on your spaceborne circuits and systems. Such software lets you model the effects of SEU on your system and identify critical circuit nodes—nodes susceptible to state changes that can cause system failure.

By combining the computer simulation with dosimetric data obtained in the lab, you can then construct a survivability profile for your system. The survivability profile defines the radiation levels your system will tolerate. With that information, you can make corrections at the design stage to harden your circuits against

the effects of an SEU occurrence. (Note, however, that SEU is not the only radiation effect that you need to be concerned about. Van Allen-belt radiation, for example, can cause long-term degradation in system performance even when it doesn't cause SEU.)

Upsets result when particles hit silicon

Single-event upset occurs when a high-energy ionizing particle irradiates a circuit or passes through an IC. In spaceborne systems, SEU can result from radiation that occurs naturally in space—cosmic radiation or Van Allen-belt radiation—or it can result from manmade sources such as nuclear explosions. The most common effects of SEU are logic-bit flips in high-density circuits, including MSI, LSI, and VLSI circuits. As **Fig 1a** shows, these state changes result when charged particles deposit charge in a semiconductor device's sensitive junction region. Protons are a special case—they create nuclear reactions, each of which generates a number of secondary reactions, including nuclear recoils, that deposit charge (**Fig 1b**). Most SEU errors are correctable or "soft" errors; usually, when a cell suffers SEU it demonstrates no degradation or change of hardware characteristics.

However, recent data indicates that SEU can cause device latchup in power MOSFETs. In such cases, SEU can cause permanent damage. If you're designing circuits for use in environments where SEUs are likely to happen, you need to understand the effects of ionizing particles on semiconductor devices so that you can protect your systems.

By analyzing models of key portions of circuits, simulation can tell you how the circuits will react when charged particles hit semiconductor surfaces.

Examining an electronic system for susceptibility to environmental radiation can be time-consuming, especially if the system consists of multiple ICs. If you know what circuits and subsystems are most likely to be affected by radiation, you can reduce the time you spend in simulating the circuit. For example, unless you take special precautions, the probability is high that SEU will alter data stored in memory elements—these elements react dramatically to SEU, and most systems contain a lot of them. It doesn't matter how data gets into a memory cell; the system can't distinguish correct information from information altered by radiation. Moreover, SEU-induced state changes can cause significant system damage. So IC memories are logical candidates for detailed simulation.

Another circuit area to explore is the registers in microprocessors. Registers often contain pointer information that, if altered, can cause the retrieval or processing of spurious data. Systems with sequential

logic also suffer from potentially damaging state changes. A state change in one node can affect the proper sequencing of the signals through the logic. SEU can affect synchronous logic, but it corrupts the data only when it occurs on the clocking phase. SEU also affects analog circuits, but not as dramatically, because analog circuits typically aren't state oriented. Nevertheless, understanding the impact of SEU on analog circuits and hardening your circuits against it can make your systems more reliable.

Upset in a static RAM—a case in point

Fig 2 is a schematic of a cell in a nonvolatile RAM, a RAM that normally retains data as long as you don't remove power from it. This cell is typical of the multiple cells that make up the RAM. As a memory cell, it's particularly susceptible to SEU-induced state changes. The accumulation of charge on the nodes that make up the cell controls the cell's state. Although the simula-

Simulator makes radiation hardening easy

When you perform circuit simulation, you must be able to describe how particles interact with semiconductor material and to analyze the electrical result. The Precise ASD software package from Electrical Engineering Software provides an easy way for design engineers to describe these behaviors and simulate them. The software runs on a variety of systems, from workstations to supercomputers. The simulator's functions are mathematical expressions that can depend on time, frequency, temperature, or any variable you choose. Because the simulation program evaluates them as the simulation progresses, these functions serve to model a variety of effects, from time-dependent switches to photocurrents generated in silicon material by nuclear explosions.

You can use the package, for

example, to describe what would happen if you were to connect a photocurrent generator to key silicon junctions of an IC. The derivation of the photocurrent translates into a mathematical expression that you then transfer to the Precise simulator. The photocurrent definition is:

$$I_{PP} = \gamma \cdot q \cdot g \cdot A \cdot L \cdot (\text{erf}(t/\tau) - u((t - PW)/\tau)) + \gamma \cdot q \cdot g \cdot A \cdot W \cdot (u(t) - u(t - PW)),$$

where I_{PP} =photocurrent in amperes, γ =dose rate in rads, $q=1.6 \times 10^{-19}$ coulombs, $g=4.2 \times 10^{13}$ carriers/(rad·cm³), A =area of junction in cm², L =diffusion depth in cm, τ =minority current lifetime in sec, PW =photocurrent pulse width (duration) in sec, W =depletion depth in cm, $u(x)$ =a unit step function of x , and $\text{erf}(x)$ =dimensionless error

function. The function $\text{erf}(x)$ equals

$$1 - (1 + a_1x + a_2x^2 + a_3x^3 + a_4x^4)^{-4} + E(x),$$

where $a_1 \dots a_4$ are coefficients and $E(x) \leq 5e^{-4}$.

You can use Precise to evaluate the photocurrent equation by creating a function file with the system editor and defining the expression. This expression uses a unit step-function definition, $u(t - PW)$. To simulate what would happen when you stimulate a circuit with the function, you place dependent current sources that reproduce the function at the circuit's critical pn junctions. Simulating with this photocurrent definition can give you an indication of how the circuit would respond to the photocurrents that would be generated by a thermonuclear explo-

tion covers a single cell, controlled sources simulate the presence of other cells. You can adjust these controlled sources to model different RAM sizes. To model the remaining cells, you multiply the source outputs by an appropriate constant.

To predict the effect of a particle's entering a circuit, you require a model for the current that's created as the particle moves through the material. As the particle passes through the depletion layer and into the substrate, it produces a track of mobile holes and electrons. These charges form along the track of the particle. The charges distort the charge distribution in the semiconductor material and cause funnel-shaped equipotential surfaces to extend into the substrate. The gradient of these equipotentials propels electrons (which are produced as the particle passes through the material) back up through the funnel, as **Fig 1a** shows.

Sufficient charge buildup will cause a change in the cell's state. If the particle passes close to the node, the

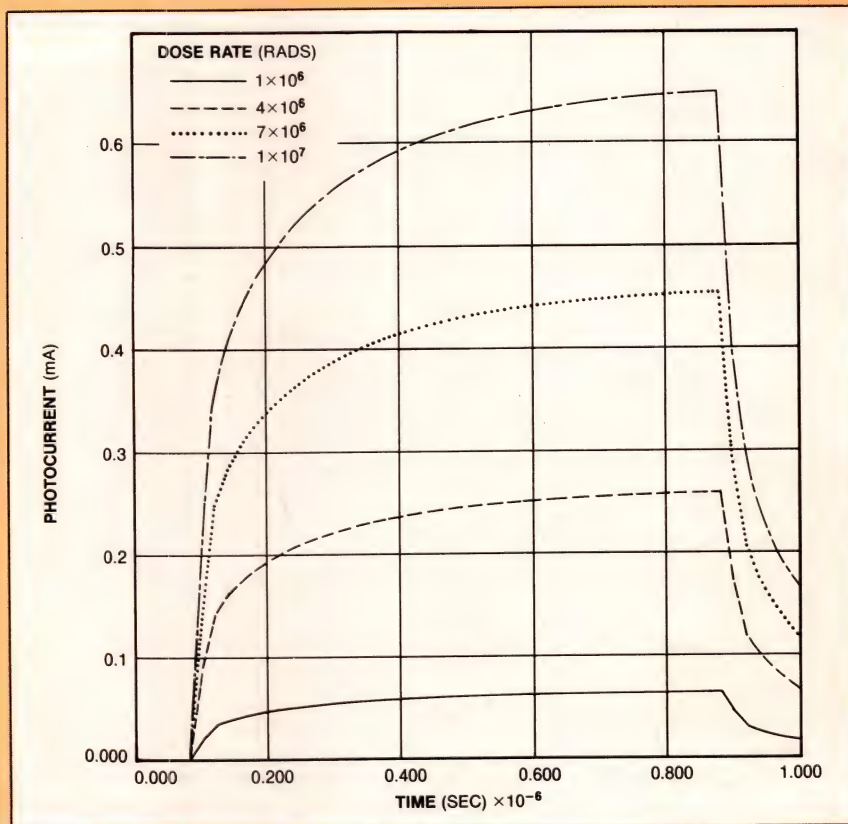
charge accumulates in picoseconds. If the particle passes further from the node, the charge-collection time is on the order of nanoseconds or microseconds. The current created by the particle depends on the semiconductor material, the charge collection, and the angle at which the particle hits.

By performing simulation, you can predict what particles and particle energies will cause the memory cell to change state. First, you must analyze the circuit with a transient simulation while using dependent-current-source modeling to model the particle's motion through the material. Next, you change the current to reflect the incident particles' differing amounts of energy and the range of angles at which they hit the semiconductor. After trying different system-hardening techniques, you can compare the circuit's response to the same upset. By simulating the circuit's response to upsets, you can test alternatives quickly, accurately, and inexpensively. If your circuit-simulation program

sion (**Fig A**).

The simulator lets you analyze the transient response while varying other parameters. This mixed-domain, or 2-dimensional, analysis gives you a family of responses based on the setting of the parameter. You can add a third dimension with the SET command. In this case you might use SET to establish a third analysis dimension in which pulse width (PW) is a parameter.

Fig A—A simulated photocurrent source shows a current buildup that reaches its final value in under a microsecond.



The most common effects of single-event upset are logic-bit flips in high-density circuits, including MSI, LSI, and VLSI circuits.

permits you to use a flexible definition of current, it can provide a picture of the survivability of the circuit state as particles with different energy hit the cell at varying angles of incidence.

Equations describe the SEU function

The simulator models the effect of a particle passing through a RAM by placing a current source on the RAM circuit, as Fig 2 illustrates. The current source is in parallel with the transistor on which the particle can have the most effect, given the circuit configuration. In this case, the most susceptible transistor is Q_4 —because

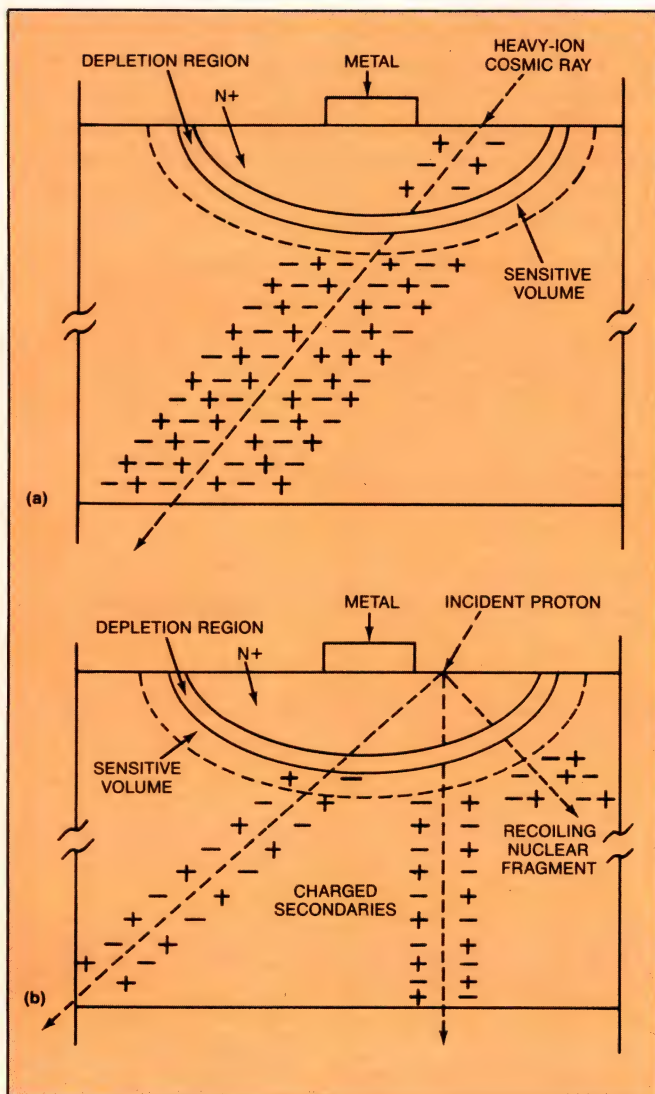


Fig 1—When most charged particles enter a semiconductor die, they deposit charge in regions of the die, and hence often interfere with device function (a). Protons create nuclear reactions, each of which generates secondary reactions that deposit charge (b).

OUT_2 is high. Over time, current builds up at the OUT_1 node. This current changes the basic state of the node. The analytical approximation of the current is:

$$I(t) = I_0 \sec \theta (\epsilon^{t/\alpha} - \epsilon^{t/\beta}),$$

where I_0 is approximately the maximum current; θ is the angle of incidence of the particle to the IC; α is a collection time constant of the junction; and β is the time constant for initially establishing the ion track. Typical values for α and β are 150 psec and 40 psec, respectively. The maximum current, I_0 , is proportional to the energy of the particle and the doping profile of the semiconductor material. I_0 varies according to the particle type—heavy ions, alpha particles, or protons. The total current increases as the angle of incidence varies from grazing to near normal.

If you formulate the basic equation as a time-dependent function, you can analyze it with a simulator such as Precise (see box, "Simulator makes radiation hardening easy"). Precise lets you define and name the function in an independent file so you can easily reference it in different circuit locations. You place the current-source element, which references the function, on the latch node of the RAM cell (Fig 2).

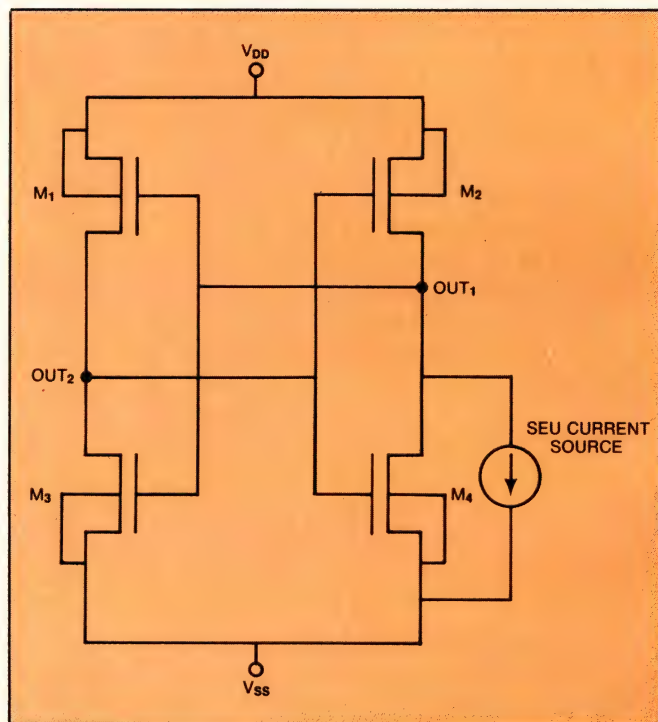


Fig 2—You model the effect of radiation on this static-RAM cell by placing a current source in parallel with one transistor.

In Precise notation, the function called "SEU" is defined thus:

```
FUNCTION SEU(I0,ANGLE)
I0*1/COS(ANGLE)*[EXPN(TIME/150PS)-EXPN(TIME/40PS)].
```

The current source, which represents the SEU function, is defined as:

```
ISEU Node1 Node2 SEU(I0,ANGLE),
```

where ISEU is the current-source definition, Node1 and Node2 define the connection of the source to the circuit, and SEU is a call to the current function that defines the particle's penetration of the semiconductor material vs current and time. You define the function by using a simple mathematical syntax available in the Precise simulator. This special language syntax lets you define behaviors quickly and easily. In this case, the function definition takes advantage of the language syntax that allows TIME to appear as a variable in the function. In addition, the SEU function has two arguments: I_0 passes into the function and takes values based on the particle of interest and the doping profile;

ANGLE is the value that determines how the particle strikes the semiconductor material.

Fig 3 shows the actual current generated from the SEU function by a particle (whose energy is represented by an I_0 of 0.5 mA) that strikes the IC die at incidence angles ranging from 0.1 to 1.3 radians (approximately 6 to 70°).

Ready . . . set . . . simulate!

You now simulate the RAM cell to see its response to the application of a selected particle energy at different angles. Precise's mixed-domain capability allows you to vary two different domains in the same simulation. In this case, you vary time and particle angle. The SEU function changes the amount of current delivered to the node during the transient analysis. While holding I_0 constant at 0.5 mA, you vary ANGLE from 0.1 radians to 1.1 radians. Fig 4 shows the result as a family of curves that represents the cell reaction to the particle current's striking at different angles. The grazing angle of 0.1 radians does not cause the cell to change state. However when the angle reaches 1.1 radians, the current is sufficient to change the state of the cell. The penetration of a charged particle and its subsequent

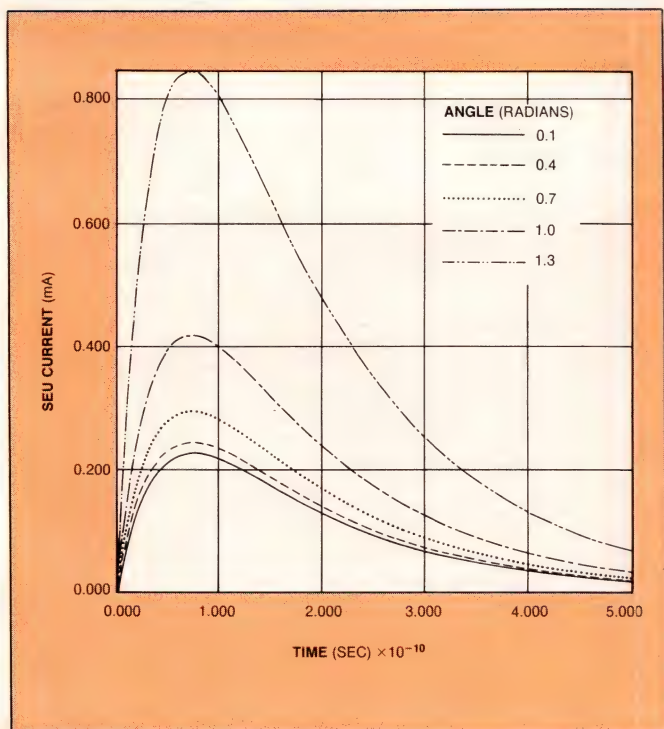


Fig 3—When particles of a given energy level strike a silicon die at angles of 0.7 radians or less, the peak current barely exceeds 0.2 mA. At larger angles, the current increases rapidly, though.

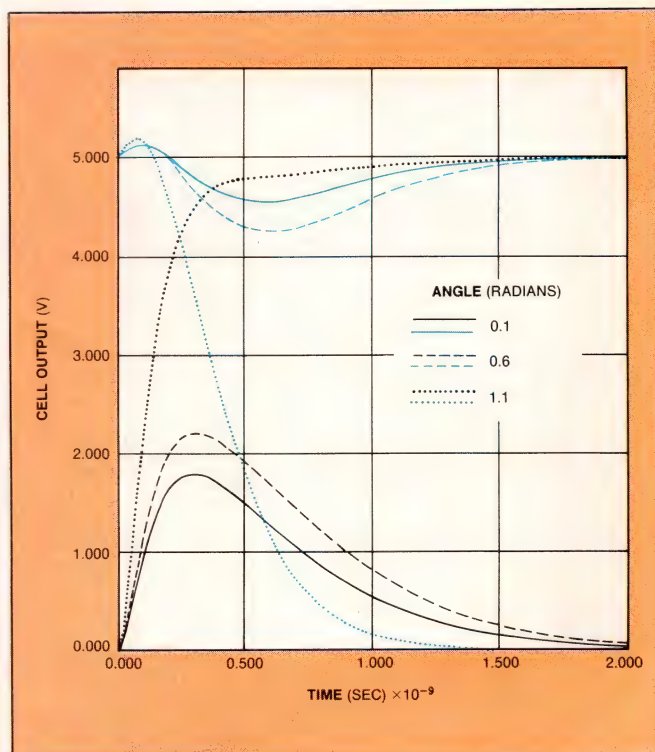


Fig 4—A particle striking the static-RAM cell at an angle of 1.1 radians or more will change the cell's state from 0 to 1 or from 1 to 0.

Unless you take special care, SEU will probably alter data stored in memory elements—and most systems have a lot of memory elements.

reaction with the semiconductor material at this current and angle is an SEU that causes a state change in the RAM cell.

For further analysis, you next set the particle angle at the nominal value of 0.7 radians. To see how sensitive the cell is to particles of different energy, you now simulate a variation in particle energy. You use particle energies that result in currents ranging from 0.1 to 1.1 mA. The resulting graph (Fig 5) shows how level shift varies with particle energy for this range of currents.

Hardening isn't necessarily hard to do

The modifications necessary to minimize the effects of SEU on your assemblies fall into three design categories: process, chip, and system. Your choice of a hardening approach will depend on your design objectives and the cost of the approach. Techniques for hardening circuits, for example, usually increase circuit costs by increasing die size or adding circuit elements for decoupling. Further, because it introduces large RC time constants, decoupling can also reduce circuit speed. You must judge each hardening technique on its effectiveness, its cost, and its effect on the system's performance.

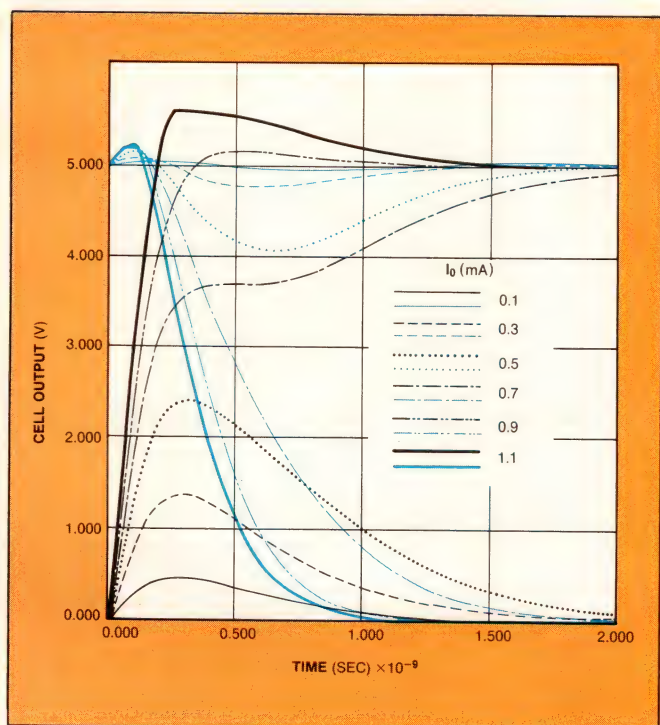


Fig 5—As incident-particle energy increases, the cell's output shifts but returns rapidly to its original level. Particles whose energy exceeds a threshold level cause the cell's state to flip.

Certain semiconductor-fabrication processes minimize SEU by using epitaxial silicon structures to truncate the charge-funneling effect. SOS (silicon-on-sapphire) or SOI (silicon-on-insulator) devices can serve this purpose. These devices can be very thin, having shallow junctions, in order to minimize the interaction time of the particles with the junctions. Retrograde junctions or buried, heavily doped layers can also help to preserve the state of the cell.

In chip design, varying the geometry to increase device widths can help preserve the cell state. By both varying the device geometry and increasing the supply voltage, you can achieve a fairly high level of hardness with relative ease. The use of decoupling resistors and capacitors or diodes can preserve the state of a latch. Adding local circuit redundancy by including additional components can strengthen nodes' resistance to state changes. You should examine the critical paths of sequential circuits for susceptible nodes. If several flip-flops are connected in series, path isolation or decoupling can prevent the propagation of an error that occurs when the state of the first flip-flop changes. Finally, from a systems point of view, using error-detection schemes such as parity checking and Hamming coding can serve to detect and correct SEU effects.

Fig 6 shows one technique you can use to harden a RAM cell. Adding a capacitor and a resistor to a pair of output nodes decouples the nodes. The result preserves

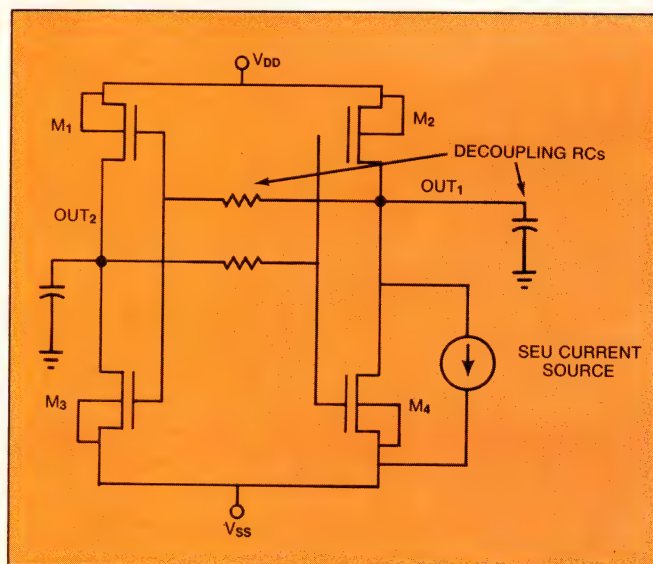


Fig 6—Adding a pair of RC networks to the static-RAM cell yields a hardened design without requiring you to change the device geometries or the fabrication process.

The Fastest Growing Electronics Newspaper



Now Reaches The Fastest Growing Electronics Market!



The newspaper is EDN NEWS.
The market, the Pacific Rim.

Starting with the December 1987 issue, EDN NEWS increases its circulation by 7,500 engineers and engineering managers in the key Pacific Rim markets of Japan, Taiwan, South Korea, Hong Kong, Singapore, and Malaysia.

This increase of 7,500 gives EDN NEWS the largest controlled circulation in the Pacific Rim of *any* electronics industry newspaper or magazine. EDN NEWS also reaches EDN magazine's U.S. circulation of 121,500...now for a total of 129,000 readers worldwide!

For details, contact Warren Dickson, Publisher, or Peter Coley, Advertising Sales Director, at (617) 964-3030 or your local EDN NEWS sales representative.

EDN NEWS

News of Products,
Technology, and
Careers for
Engineers and
Engineering
Managers

Cahners Publishing Company • 275 Washington Street
Newton, MA 02158-1630 • (617) 964-3030

With simulation, you can predict what particles and particle energies will cause a memory cell to change state.

the charge on the node during an upset, making the circuit less likely to switch states.

To study the impact of the added components, you can run another transient simulation. From Fig 7 you can see that the particle energy that caused a change in the cell state no longer has an effect; however, the additional components increase the circuit's complexity. You can also change the device geometries to prevent an upset from causing a shift in state. Because it doesn't increase circuit complexity, changing geometry can be more cost effective than adding components. You can easily test this hardening alternative by changing the device dimensions and resimulating. To study the cell reaction to the SEU function, you set up the device dimensions as Precise variables and conduct the simulation with varying device widths and lengths.

Simulation helps raise reliability

Analyzing SEU by using simulation is an effective means of identifying potential circuit problems before they occur in production systems: In effect, simulation lets you harden a system before building it. Further, simulation is a cost-effective alternative to dosimetric prototyping for SEU analysis. Finally, circuit simulation is a fast and accurate method of studying different hardening techniques for overall effectiveness. Al-

though the example presented here addresses only SEU, simulation is just as useful for analyzing other environmental effects on circuits—for example, temperature and mechanical stress—as well as the effects of parameter variation in manufactured components.

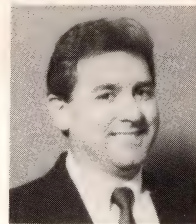
EDN

References

1. Abramowitz, M, and I Segun, *Handbook of Mathematical Functions*, National Bureau of Standards, Gaithersburg, MD, 1986.
2. Gauthier, M K, and A R V Dantas, "Radiation-effects testing for space and military applications," *Test and Measurement World*, February 1988, pg 51.
3. Messenger, C G, "Collection of charge on junction nodes from ion tracks," *IEEE Transactions on Nuclear Science Volume NS-29, No 6, December 1982*, pg 2024.
4. Messenger, C G, and M S Ash, *The effects of radiation on electronic systems*, Van Nostrand-Reinhold Co, New York, NY, 1986.

Authors' biographies

Kevin Walsh is vice president of marketing at Electrical Engineering Software (Santa Clara, CA), where he has been employed for three years. He holds a BS in electrical engineering and computer science from the University of California at Berkeley. Kevin has been working in the computer software field for over 10 years. He is a member of IEEE, and in his spare time he enjoys sailing, skiing, and golf.



Gary Lum is a staff engineer and device physicist at Lockheed Missiles and Space Co (Sunnyvale, CA). He has been with the company for six years. He holds a BS in physics from the University of California at Berkeley and MS and PhD degrees in physics from the University of Oregon. Before joining Lockheed, he worked at Intel on the development of large-capacity EEPROMs. Gary is a member of the American Physical Society, and is too engrossed in his work to list any spare-time activities.

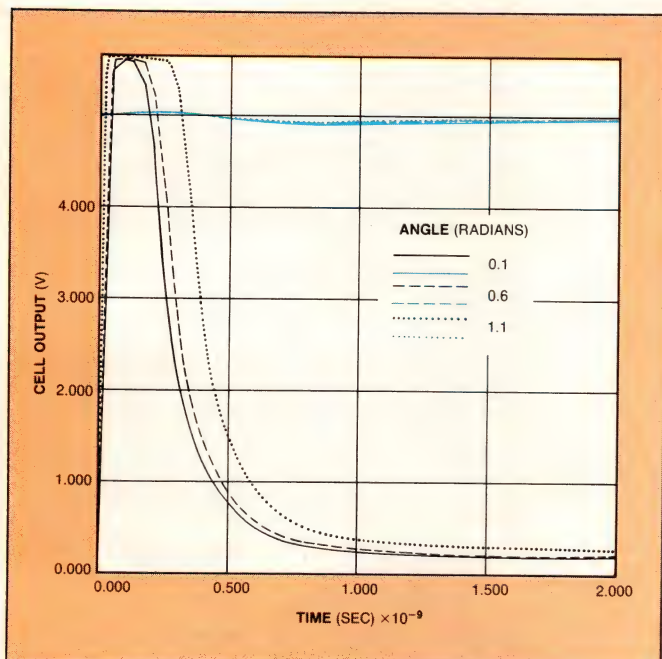
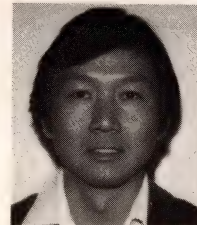
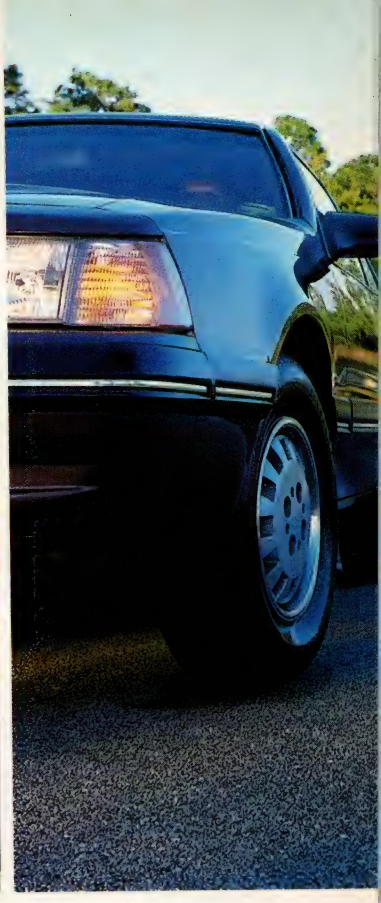
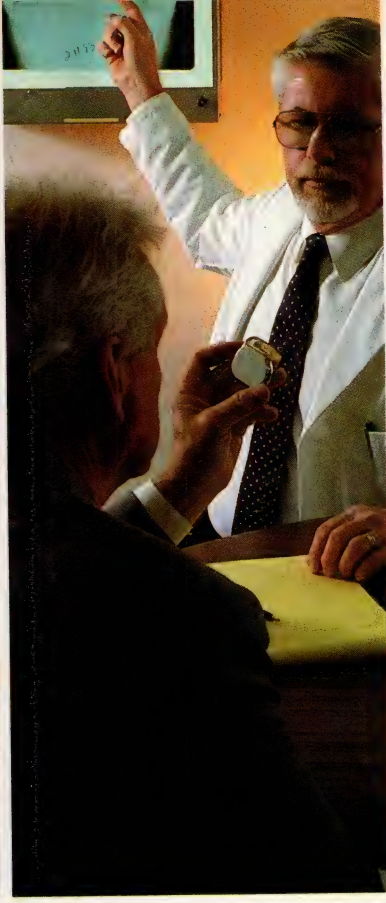
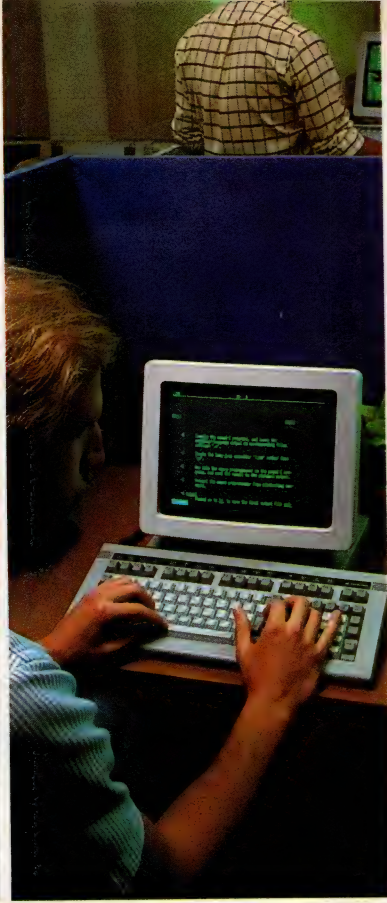


Fig 7—When you add components to the design and run another transient simulation, you find that particles that caused the original cell to change states no longer affect the cell's output.

Article Interest Quotient (Circle One)
High 494 Medium 495 Low 496



1 in Tantalum Chips...and We've Only Touched the Surface!

Mepco/Centralab SMD® tantalum chips reduce your system's size and increase its performance in every application — military, telecommunications, information systems, medical, automotive — and give you the broadest selection.

For peak reliability and volumetric efficiency, systems designers take our patented, conformally coated "Blue Chip®" to heart — in fact, it's used in 95% of the world's implanted pacemakers. And it's the **only** military hi-rel chip (CWR06 to MIL-C-55365) approved to reliability levels M, P, R, B, C and D!

Our "Star Chip®", the cost-effective alternative for your high-volume industrial applications, provides design flexibility not available with molded chips. Its patented features make it ideal for super computer (cryogenic) use, and for switching power supplies at 100 kHz and greater.

Our "Ultra Chip" is the ultimate in real estate efficiency, and our uniform-sized "Molded Chip" (approved to MIL-C-55365, Type CWR11) is available at very attractive prices.

A leader in leaded parts, too.

Our axial-leaded, hermetically sealed cylindrical and modular wets and solids meet the requirements of MIL-C-39006, -39003, and more. With capacitances from 0.0047 to 22,000 μ F, for operation on 3 to 630 vdc. And large-capacity programs to meet your dock-to-stock and J-I-T requirements.

Write for our catalogs and get acquainted with America's broadest line of tantalum chip capacitors — from Mepco/Centralab, the active leader in passive components.

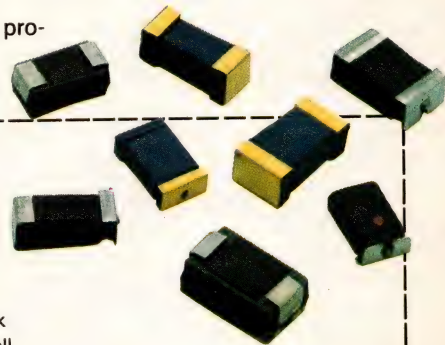
Mail to: Mepco/Centralab
Attn: Corp. Advertising
2001 W. Blue Heron Blvd.
Riviera Beach, FL 33404.

Please send me the following:

- ☐ Surface-Mount Device Catalog
- ☐ Leaded Resistor/Capacitor Data Book
- ☐ Please have a sales representative call

Name/Title _____
Firm/Dept./Div. _____
Address/MS _____
City/State/Zip _____ Phone () _____

EDN081888

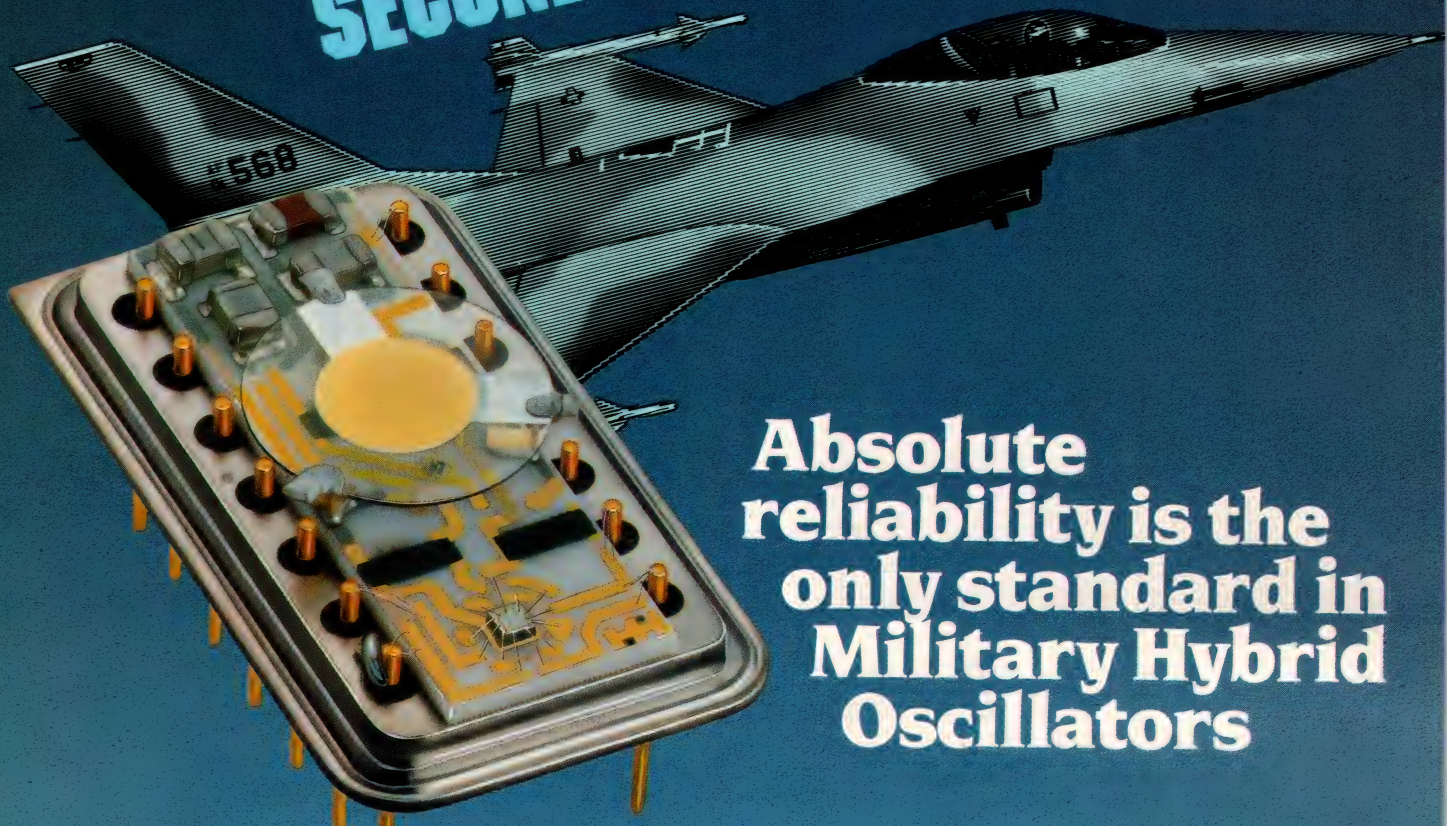


MEPCO/CENTRALAB
A DIVISION OF NORTH AMERICAN PHILIPS CORPORATION



®SMD is a service mark of North American Philips Corporation.

SECOND-RATE DOESN'T GET BY!



Absolute reliability is the only standard in Military Hybrid Oscillators

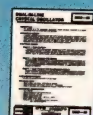
That's why more and more military product specifications call for CTS Hybrid Clock Oscillators.

CTS is qualified to MIL-0-55310. Pioneer builders of clock oscillators—we built some of the first units for the military 20 years ago—CTS is one of the largest broad line hybrid oscillator companies in the entire world.

Because of our long expertise in the field, CTS does things competitors can't or won't do. We do all of our own quartz processing to assure reliable crystal performance. Our military hybrid oscillators are life tested to verify long-life performance standards. Our hybrid designs undergo comprehensive testing and

process control before, during and after production. Test capabilities: RGA, TGA, SEM/EDS, component shear, bond pull, vibration, shock, acceleration, PIND, aging, burn in, temp cycle. CTS military hybrid clock oscillators deliver outstanding reliability.

WRITE TODAY for bulletin detailing the complete line of CTS military hybrid oscillators. Contact: CTS Corporation, Frequency Controls Division, 400 Reimann Ave., Sandwich, IL 60548. Phone: (815) 786-8411.



Write your own specifications on CTS hybrid oscillators—or, we'll meet MIL-0-55310

Whether you need a standard or a custom oscillator, our staff of engineers will design in exactly the performance characteristics your application requires. CTS hybrid oscillators deliver consistent, long life performance, require less power, take less space. Competitively priced, naturally.

Call TOLL FREE 1-800-982-0030 for name and location of nearest CTS Sales Engineer

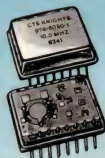
CIRCLE NO 19

CTS. MEANS RELIABILITY

CTS CORPORATION • ELKHART, INDIANA



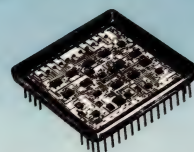
Series CCXO-140 Leadless Chip Carrier Crystal Oscillator for surface mounting.
Phone: (815) 786-8411
CIRCLE NO 20



Custom Crystal Oscillator with multiple integrated functions.
Phone: (815) 786-8411
CIRCLE NO 21



Two-piece Military Connectors MIL-C-55302/4 and MIL-C-55302/6.
Phone: (612) 533-3533
CIRCLE NO 22



Hi-Rel Hybrids Custom microcircuit for advanced military communications system.
Phone: (317) 463-2565
CIRCLE NO 23

Who leads the ranks in military ICs? The General does.



The General has mobilized the greatest army of Hi Reliability ICs ever. There are troops of leadless chip carriers, flat packs, power packages, cerdips, side brazed, standard metal cans, and our newest recruit, the hermetic TO-220. It's an army of pulse width modulators, supervisory circuits, power supply ICs, regulators, FET drivers, memory drivers, diode arrays, and transistor arrays.

The introduction of the Hermetic TO-220 is another example of the General's commitment to the demanding requirements of the military marketplace.

Other examples include:

- Radiation hardened devices
- Military hybrids
- Flat packs/LCCs
- New JAN quals
- Aggressive deliveries.

You'll like the General's allies too:

• Mil-M-38510 • Mil-S-19500 • Mil Std 883 Class B, Class S • Mil/DESC Drawing • SCD.

Call Silicon General for our new short form catalog and an updated JAN QPL listing (including 7800, 7900 series regulators in process). Please address Silicon General, 11861 Western Ave., Garden Grove, CA 92641. Phone (714) 898-8121, TWX (910) 596-1804, FAX (714) 893-2570.

**SILICON
GENERAL**

A TIP OF THE HAT TO OUR NEW ALLIES IN MILITARY RESISTORS: RCL AND SHALLCROSS

A worldwide force you can deal with.

The world's widest selection of quality wirewound resistors just got wider.

Recognized for their MIL-STD lineup of power and precision resistors, customs and networks, RCL and Shallcross are joining forces with IRC, a member of the Crystalate Group.

Specify MIL-grade parts or choose commercial-grade components built to the same high-performance standards.

For you, the new alliance means more than resistor choices. It means more services, too. RCL and Shallcross' QTASM and IRC's GRIDSM programs guarantee delivery from three days to three weeks at premium prices. You'll also benefit from EDI paperless purchasing, SPC for unsurpassed product quality and "dock-to-stock" inventory management for your JIT needs.

Put it all together and you have a cost-saving maneuver that meshes perfectly with your time-to-market strategies. Call the sure source for the resistor specs and assistance you need to outflank the competition. IRC, RCL and Shallcross will cover you.

RCL: 195 McGregor St., Manchester, NH 03102; (603) 627-3831. Shallcross: U.S. Hwy. 70 East, Smithfield, NC; (919) 934-5181.



Wirewound

MIL-R-18546...Style RE
MIL-R-39009...Style RER
5 TO 250 W
0.1 Ω TO 180K Ω
TOL. $\pm 1\%$

MIL-R-26...Style RW
MIL-R-39007...Style RWR
0.4 TO 15 W
0.1 Ω TO 200K Ω
TOL. $\pm 0.1\%$ TO 10%

MIL-R-93...Style RB
MIL-R-39005...Style RBR
0.1 TO 2.5 W
0.1 Ω TO 30M Ω
TOL. $\pm 0.01\%$ TO 1%

Metal Film

MIL-R-39017...Style RL R
MIL-R-55182...Style RNC
1/8 TO 1 W
10 Ω TO 3.01M Ω
TOL. $\pm 0.1\%$ TO 2%

Networks

MIL-R-83401...Styles SIP, DIP, FP
Full Line Approval
50 Ω TO 100K Ω
TOL. $\pm 0.02\%$ TO 2%

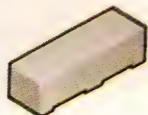
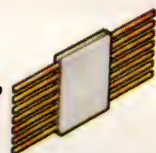
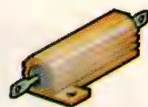
Commercial

LO OHM
3 AND 5 W
0.005 Ω TO 0.1 Ω
TOL. $\pm 0.5\%$ TO 5%

AS-SMS Series
3 W
0.1 Ω TO 1.5K Ω
TOL. $\pm 0.25\%$ TO 5%

LPW-SM Series
2 W
0.01 Ω TO 0.5 Ω
TOL. $\pm 1, 2$ & 5%

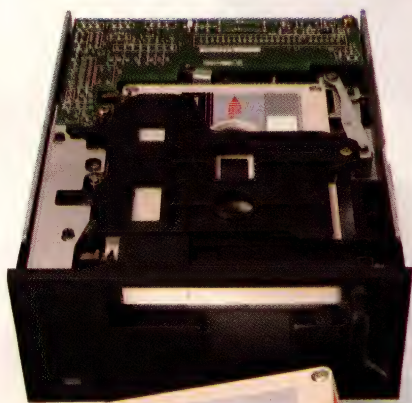
CHIP Series
1/8 TO 2 W
1 Ω TO 5.1M Ω
TOL. $\pm 0.5\%$ TO 5%



RCL·Shallcross



A 155MB 3.5" Format Cassette Data Streamer?



MT-2ST/N50



Yes, 155MB on the TEAC MT-2ST/N50. In a data streamer the size of a standard 3.5" microfloppy disk drive—including SCSI interface. With backup under software control for everything from a single file to an entire hard disk. And read-after-write data verification with sophisticated error correction for the high-est data integrity.

A surprising extra: full media compatibility. So that a backup cassette made on one data streamer can be read on any other. This makes data cassettes an ideal means of exchanging or distributing large volumes of data.

Less surprising is the fact that the few Japanese computer manufacturers who haven't already adopted the MT-2ST/N50 are actively considering it. —for its clear advantages in compact size, huge backup capacity, and data interchangeability.

TEAC

TEAC CORPORATION

3-7-3 NAKA-CHO,
MUSASHINO, TOKYO, JAPAN
TEL: (0422) 52-5041
TLX: 2822451
FAX: (0422) 55-2554

For Memories You'll Be Glad To Have

■ **Hong Kong**, Nissei Sangyo Co., Ltd. Hong Kong Branch Tel: 3-343441-6;
KARIN ELECTRONIC SUPPLIES CO., LTD. Tel: 3-898252 ■ **Singapore**, Nissei
Sangyo Pte. Ltd. Tel: 65-7372011 ■ **New Zealand**, Northrop Instruments &
Systems Ltd. Tel: 856-658 ■ **Australia**, AWA TECHNOLOGY GROUP Tel: 02 888
9000 ■ **Indonesia**, CHUGAI BOYEKI CO., LTD. Tel: 370824 ■ **Philippines**,
COMPEX INTERNATIONAL INC. Tel: 213020 ■ **India**, Priya Electronics &
Chemicals Limited Tel: 2863611 ■ **Kuwait**, Bader Al Mulla & Brothers Co. W.L.L.
Tel: 2423250 ■ **United Kingdom**, TEKDATA LIMITED Tel: 0782 577677 ■ **F.R.**
Germany, nbn Elektronik GmbH Tel: 08152/390 ■ **Austria**, nbn Elektronik
GmbH Tel: 0316/40 28 05 ■ **Netherlands**, SIMAC ELECTRONICS B.V. Tel:
040-582911 ■ **Belgium & Luxembourg**, SIMAC ELECTRONICS SPRL Tel: 02-
252.36.90 ■ **France**, TEKELEC AIRTRONIC S.A. Tel: (1)4534-75-35 ■ **Italy**,
A.E.S.E. S.p.A. Tel: 02-54.64.741-2-3 ■ **Spain**, ATAIO Instrumentos S.A. Tel:
733 05 62 ■ **Switzerland**, WENGER PERIPHERALS AG Tel: 01/830 75 55
■ **Denmark**, Dansk Binær Teknik A/S Tel: 03-662020 ■ **Sweden**, MACROTEK
AB Tel: 08-733 02 20 ■ **Norway**, SCANTELE AS Tel: (2) 65 69 20 ■ **Finland**,
INSTRUMENTARIUM ELEKTRONIKKA Tel: 0-5284350

* If no distributor listed above is in your area, please contact us directly for further details about our products.





Field ready.

**MIL-C-39012:
Crimp BNCs, Category F SMAs.
Fast, simple, consistent.
Deal us your toughest jobs.**

Current production environment: do it better, do it faster. When it comes to the business end of a coax line, we help. Everything we offer—from BNCs to SMAs—meets spec, lowers costs, and puts you ahead of the clock.

Our Category F crimp SMA for semi-rigid cable, for example. Typical termination time: 15 seconds. No X-ray testing. Our phase Match Kit gets you performance out to 26.5 GHz, on the first try. And the crimp is so secure that finished terminations

handle vibration levels that would tear soldered connections apart.

Our blind mate versions float just enough to make life bearable in tight spots. And our retractable coupling nut version allows visual alignment for perfect mating.

Call us at 1-800-522-6752. We're ready to field your questions and requests. AMP Federal Systems Business Group, Harrisburg, PA 17105-3608.

AMP Interconnecting ideas

THREE VAST IMPROVEMENTS IN ANALOG ASICS: SPEED, PRECISION, AND SIPEX.

Forget everything you know about analog ASICs and consider the performance you'll gain from our DataLinear Division's new SP1104 analog array: speed, precision, and density all in one chip.

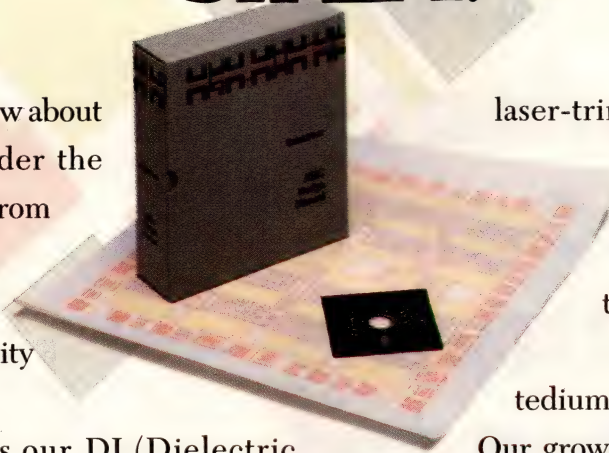
The SP1104 uses our DI (Dielectric Isolation) process, so you can forget about parasitic junction-isolation effects like latch-up. You can also forget about the design limitations imposed by low performance PNPs. Our SP1104 uses full-complementary, high-bandwidth, vertical NPN ($F_T \approx 1$ GHz) and PNP ($F_T \approx 600$ MHz) transistors, both without collector-connection restrictions.

And forget about the problems of temperature tracking and precision. Our SP1104 uses low temperature-coefficient (100 ppm/°C), nichrome, thin-film resistors and they're even

laser-trimmable, down to .01% ratio matching, for that extra measure of precision. All this with a max voltage up to 35V.

And forget about the tedium of transistor-level designing. Our growing macro-cell library already includes op-amps, comparators, references, and transimpedance amplifiers. And finally, forget about another expensive software investment. We interface with industry-standard simulation packages, like P-SPICE and H-SPICE, and our layout package can run on any GDS II compatible workstation.

For a detailed description of the SP1104 and a copy of our 1988 product catalog, call 1-800-272-1772. In Massachusetts, call (508) 663-7811. Or write Sipex Corporation, DataLinear Division, 491 Fairview Way, Milpitas, CA 95035.



Sipex DataLinear
Corporation Division

SIGNAL PROCESSING EXCELLENCE

**If you're
not satisfied
with the quality
of any
Unitrode discrete
semiconductors,
we'll replace
them and
tear up the bill.**

In the past year, we've invested a lot in quality and customer satisfaction. We've worked hard and we've upgraded equipment and facilities, operating systems and controls, training, and documentation systems. We've set our sights on making our products and service the best in the industry.

It's paying off. We're shipping highest quality—100% tested products that meet or exceed *all* parameters of the specs.

If you purchase discrete semiconductors directly from Unitrode and any of those parts have electrical or mechanical failures within 60 days of delivery, just call us for an RMA. We'll take back the unused, failed parts and replace them free. **You will pay only for the parts that passed the first time around.**



Unitrode Semiconductor Division
580 Pleasant Street
Watertown, MA 02172
(617) 926-0404

**We value your business.
Put our products to your test.**

Now there's an 80C86 built specially for harsh military and space environments!

First power-saving 16-bit rad-hard CMOS μ P family.

You should see what happens to our 80C86RH μ P when exposed to 100K rads total dose. That's right. Absolutely nothing!

With its built-in hardness, the 80C86RH is designed to thrive in harsh environments. Guaranteed, in fact, to meet data sheet specs after exposure.

Our new CPU makes bulky shielding obsolete. New specialized peripherals replace many discretes and pare chip count and costs even further.

All are 100% pin- and software-compatible with 8086 NMOS systems, and with Harris' standard 80C86. And you avoid the expense of developing software: it's already available.

You can prototype with standard 80C86 parts then retrofit with our new rad-hard compatibles — after systems are tested and working.

Want to outshine the competition? Then give your systems a flare for the dramatic...design-in our rad-hard 80C86 family.

For details and a data book, contact Harris Systems Ltd., Semiconductor Sector, Eskdale Road, Winnersh Triangle, Wokingham, Berks RG11 5TR England or call 0734 698787.

New rad-hard 16-bit CMOS peripherals

82C85RH	Static Clock Controller/Generator
82C37ARH	DMA Controller
82C54RH	Interval Timer
82C55ARH	Programmable Peripheral Interface
82C52RH	Serial Controller Interface (Q1, '89)
82C59ARH	Programmable Interrupt Controller (Q1, '89)



"A rad-hard 16-bit
 μ P family now.
A 64K rad-hard SRAM
on SOI soon..."

"Both made for space
survival...what a
brilliant idea."



IN RAD-HARD CMOS ICs, THE NAME IS

HARRIS

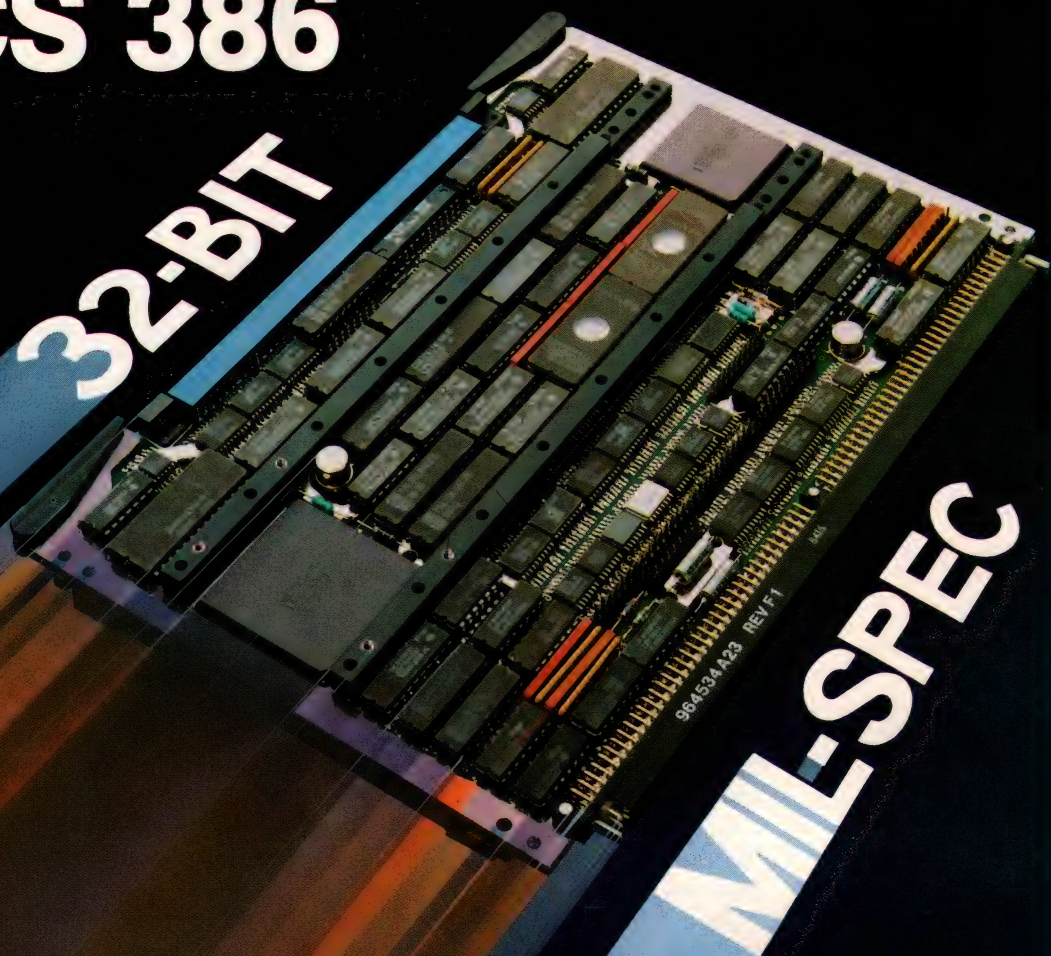
Harris Semiconductor: Analog - CMOS Digital
Gallium Arsenide - Semicustom - Custom



©1988, Harris Corporation

SECS 386

32-BIT



MIL-SPEC

A NEW GENERATION OF COMPUTERS!

For 10 full years, TITAN/SESCO has been supplying its complete line of NDI Mil-Spec SECS 80 computer products to major defense programs. Now, with the introduction of our new 32-bit SECS/386 computer engine, the processing requirements of tomorrow's programs can be handled...TODAY!

FEATURES OF THE SECS 386

- NDI 32-Bit Military Computer
- 16 MHz Intel 386 CPU & 387 NPE
- MULTIBUS Based
- Fast 32-Bit LOCALBUS Processing
- Available NDI 32-Bit Companion Memory Boards
- Ada Software Support
- Real Time Multitasking Operating Systems Support
- Standard Software Development Environment
- Radiation Hardened Version
- Full Logistics Package
- Manufactured per MIL-Q-9858A

For California Calls
1-800-441-2345 Ext. 143

TITAN
SEVERE ENVIRONMENT SYSTEMS

A Subsidiary of The Titan Corporation

For National Calls
1-800-556-1234 Ext. 143

20151 Nordhoff St., P.O. Box 2668 • Chatsworth, CA • 91313-2668 • In CA (818) 709-7100/Telex 69-1404

Peer-to-peer protocol facilitates real-time communications

The low communications overhead of the CSMA/DCR peer-to-peer protocol makes it desirable for real-time network applications. Further, the protocol's guaranteed network-access time relieves the designer from worst-case haunts.

Deif N Atallah, Intel Corp

By definition, real-time-communication networks need to transfer information between nodes as quickly as possible. Preferably, these transfers should occur within a guaranteed maximum time limit. Networks have traditionally achieved real-time communications via some type of master/slave protocol, contention-based protocol, or token-based protocol—each with their own advantages and disadvantages. A relatively new contention-based protocol, based on the advantages of each of these methods, enhances the information-transfer rate of a real-time network.

A master/slave protocol is a popular method for real-time communications because it guarantees that all the nodes on the network will gain access. Examples include the Synchronous Data Link Control (SDLC) and High Level Data Link Control (HDLC) protocols. A

master/slave protocol requires the management of a significant amount of overhead, however, which in itself occupies valuable bandwidth. A master node has to first poll the slave nodes to initiate communication, and it must then take control of the link to ensure that communication takes place. If the network has multiple masters, they must arbitrate for control of the network, so that a maximum access time cannot be guaranteed.

Token-passing protocols, in contrast, guarantee a maximum access time for each node on the network by sequentially passing a token around to each node. To avoid contention, each node must acquire the token before transmitting information. Even if the network is quiet, however, a node must wait until the token goes all the way around the network. If there are many nodes on the network, the guaranteed maximum access time can be long. Examples of token-passing protocols are the IEEE 802.4 and 802.5.

A peer-to-peer communication protocol such as the Carrier Sense Multiple Access with Collision Detection (CSMA/CD), which is what Ethernet uses, has low communications overhead. It can't guarantee a maximum access time to the network, however, because it resolves contention problems statistically. The CSMA/CD lets a node monitor the network for a quiet period in which to send its message. If messages from two nodes collide, the two nodes have to wait for a random interval of time and then they attempt to retransmit. Although you can choose network parameters to minimize the

The CSMA/DCR protocol guarantees a maximum access time to the network, yet it has the same low communications overhead as the CSMA/CD.

probability of successive collisions, you can't be guaranteed of a maximum access time because of the protocol's nondeterministic recovery mechanism.

Determinism offers a guarantee

A variation of the CSMA/CD protocol, the CSMA/DCR (deterministic collision resolution), merges the advantages of the aforementioned protocols. The protocol features the same low communications overhead as the CSMA/CD, yet guarantees a maximum access time to the network.

The protocol operates in a peer-to-peer CSMA/CD mode until a message collision occurs. Any node on the network can initiate communications without polling for a response. This lack of polling overhead maximizes the link's bandwidth. Essentially, the physical layer of the OSI (open system interconnection) model looks for opportunities to transmit by monitoring the network's activity. This network-access scheme, coupled with the guaranteed access time of the resolution phase, produces a very efficient network even during heavy traffic conditions.

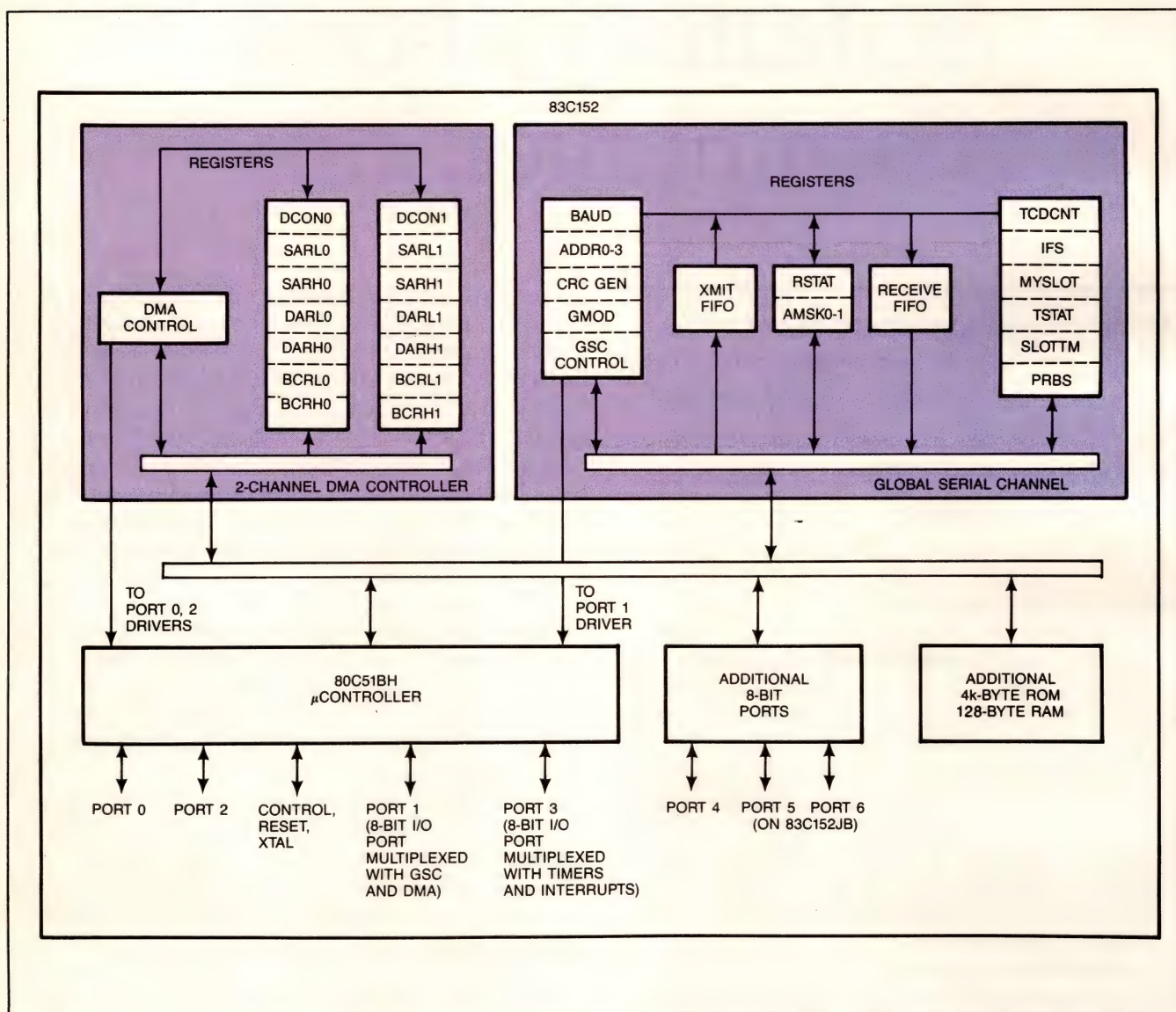


Fig 1—The 83C152 communication controller has a multiprotocol Global Serial Channel (GSC) and two DMA channels functioning as peripherals for the 80C51BH μ controller. Different versions of the 83C152 offer additional ports.

When a collision takes place, all of the nodes on the network, regardless if they are involved in the collision, enter into something called a resolution phase. The worst-case access time is equal to the maximum time of the resolution phase, which you can calculate from the network's configuration and parameters. During the resolution phase, the protocol assigns each node on the network a programmable time slot for data transmission. During its allotted time slot, a node has the option of transmitting a message. The node's maximum allocated frame length determines the length of the message. This type of recovery sequence eliminates the possibility of successive collisions.

A single IC can do it all

The Intel 83C152 is an example of a single-chip VLSI communication controller that implements the CSMA/DCR protocol (Fig 1). (It implements several others as well, including the CSMA/CD protocol.) The IC has an 80C51BH microcontroller core that contains an asynchronous serial port, 4k bytes of ROM, 128 bytes of RAM, four 8-bit parallel-I/O ports, and two 16-bit timer/counters. The IC also has an extra 4k bytes of ROM and an extra 128 bytes of RAM.

The core interfaces to two on-chip peripherals: a 2-channel DMA controller, and a multiprotocol serial channel, the Global Serial Channel or GSC. The DMA channels service both the GSC and the local serial channel. The DMA channels offload the communications overhead from the CPU and arbitrate for shared-memory resources via a hold and a hold-acknowledge bus-access control. The 83C152 interfaces to a serial backplane through open-collector drivers and receivers. To drive larger networks, it uses active drivers such as RS-485 transceivers (Fig 2).

Initially, the user code loads the network parameters, including the nodes' slot position, the interframe space (IFS), the slot time (ST), and the maximum number of slots for the network, into the GSC's internal registers. The controller permits 63 nodes on the network to participate in collision resolution. The network can also have an additional node that doesn't participate in collision resolution. The controller must assign slot number 0 to this additional node to prevent it from transmitting during the resolution phase. A data-gathering station would be a typical example of a node with slot number 0.

During the resolution phase, the slot numbers decrement from the maximum number of nodes on the network to slot number 1. The GSC loads the prepro-

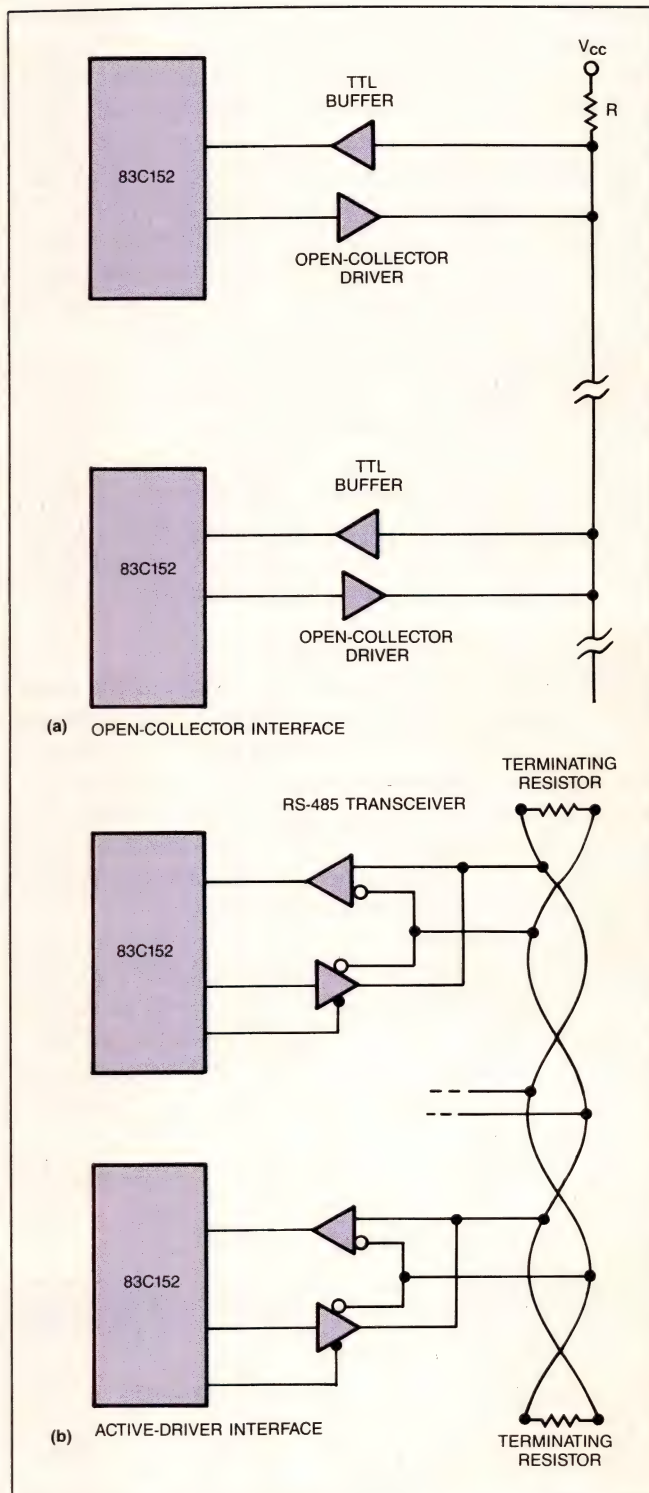


Fig 2—You can interface the 83C152 to a backplane using open-collector TTL buffers (a). The multiprotocol controller can also interface to larger networks via RS-485 transceivers (b).

During the resolution phase, the CSMA/DCR protocol assigns each node on the network a time slot for data transmission.

grammed maximum number of slots into the decrementing slot counter. It must then wait one IFS after it senses that the link is idle. The IFS is the quiet time on the network between successive frame transmissions. Following this interval, the slot counter decrements when either of the following conditions occur: A slot time expires without detecting any link activity, or the controller detects link activity and an IFS expires after the link becomes idle. When the slot counter matches a node's assigned slot number, the protocol permits the node assigned to that slot number to transmit.

Fig 3 depicts the resolution phase of a 6-node network. The CSMA/DCR protocol encapsulates data into frames similar to the CSMA/CD protocol: Each frame consists of a preamble bit pattern, the destination address, a message field, and cyclic-redundancy check (CRC) bits. The preamble bit pattern provides synchronization data for all the receivers on the network, allowing them to decode the Manchester-encoded data.

Now you can calculate the worst case

The CSMA/DCR protocol relies on two of the same network parameters that the CSMA/CD protocol uses—the IFS and the ST. The network nodes must wait at least one IFS while doing peer-to-peer communications and when recovering from a collision. The IFS also lets the physical medium recover after a transmitted frame and ensures that the other network sublayers have time to synchronize data for transmission.

The ST, or collision window, represents the maximum amount of time that there is invalid data resulting from a collision on the network. It is at least as long as the sum of the round-trip propagation delay (RPTD), the collision-detection time (CDT), and the jam time

TABLE 1—NETWORK PARAMETERS

DATA PROTOCOL	CSMA/DCR
DATA RATE	2M BPS
NETWORK LENGTH	500m
WORST-CASE ACCESS TIME	8 mSEC
INTERFRAME SPACING	96 BIT PERIODS = 48 μ SEC
JAM TIME	32 BIT PERIODS = 16 μ SEC
COLLISION-DETECTION TIME	1 BIT PERIOD = 0.5 μ SEC
SLOT TIME	64 BIT PERIODS = 32 μ SEC
ROUND-TRIP PROPAGATION DELAY	4.7 μ SEC \approx 10 BIT PERIODS

(JT). The RPTD is equal to twice the network length divided by the propagation speed (approximately 2.1×10^8 msec). The CDT is the time required for the circuitry to detect a collision. The JT lasts for either a 16 or a 32 bit period, depending on the number of CRC bits you program into the 83C152. The 83C152 detects a collision on every bit by verifying whether the transitions of the Manchester code are valid.

The 83C152 programs the IFS and the ST in multiples of the bit period. (A bit period is the inverse of the bit rate). The controller programs each IFS and ST independently; the maximum length of each can be 256 bit periods. During the resolution phase, the calculated worst-case access time is equal to the ST plus an IFS plus the sum of the maximum frame time allotted for each node and an IFS for each frame. In other words:

$$\text{Access Time(WC)} = \text{ST} + \text{IFS} + \sum (\text{Maximum Frame Time}(i) + \text{IFS}),$$

where the access time(WC) is the worst-case access

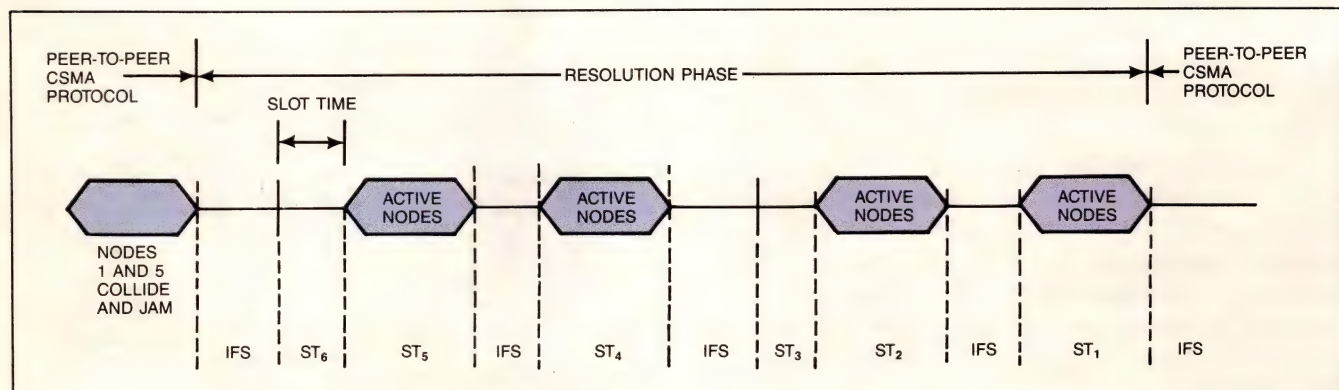


Fig 3—In this sample configuration of a 6-node network operating with the CSMA/DCR protocol, nodes 1 and 5 collide during peer-to-peer CSMA communications. When the network becomes idle, all the nodes on the network enter the resolution phase. After an interframe space (IFS), the slot counter decrements from ST₆ to ST₁. Active nodes transmit frames during their respective slot assignments.

time; the $ST > RTPD + CDT + JT$ as stated above; the sum takes into account all the nodes on the network; and the maximum frame time(i) is the maximum frame time of the i th node.

When all of the network nodes have the same maximum frame time size, the worst-case access time is

$$\text{Access Time(WC)} = ST + IFS + n \times (\text{Maximum Frame Time} + IFS),$$

where n is the number of nodes on the network. In both formulae, the frame time is equal to the number of bits in a frame divided by the bit rate.

An example will help to illustrate how the network parameters determine the access time. Consider the case of a 2M-bps control network that communicates

over a data link having 32 nodes. Two of the nodes have a maximum frame size of 500 bytes, which is typical of a motor controller. The remaining 30 nodes have maximum frame sizes of 20 bytes, which is typical for devices such as sensors and valves. For this sample network, and for the accompanying network parameters listed in **Table 1**, the worst-case access time is approximately 8 msec.

Because the CSMA/DCR protocol guarantees a maximum access time, you can adjust the network parameters for optimum operation. For the same 2M-bps network, **Fig 4** shows the variations in worst-case access time that result when you manipulate two network parameters—the maximum frame size and the number of network nodes. Curves for other network parameters are similar, and therefore you can custom-

LISTING 1—SAMPLE CODE FOR THE 83C152's GSC

```
MOV GMOD, #7CH          ; select CSMA protocol, Manchester
                          encoding, 32-bit preamble, 32-bit
                          Autodin CRC, alternate back-off,
                          transmitter operation with internal baud
                          generator and 16-bit addressing.
CLR DMA                  ; select GSC operation without DMA
MOV BAUD, #00H           ; set baud rate to 2 Mbps for 16 MHz
                          clock
ANL PCON, #0F7H         ; select receiver operation with
                          internal baud generator
                          ; set first station address to 1005H
MOV ADR0, #05H
MOV ADR1, #10H
MOV ADR2, #06H
MOV ADR3, #20H
MOV IFS, #060H           ; set Interframe Spacing to 96 bit times
MOV SLOTTM, #40H        ; set Slot Time to 64 bit times
MOV TDCNT, #20H         ; set maximum number of stations to 32
MOV PRBS, #0FFH         ; freeze the Pseudo-Random Binary
                          Sequence generator for proper DCR
                          operation
MOV MYSLOT, #0C5H        ; select station slot assignment to 5,
                          select DCR mode and DC-type jam.
```

Depending on the application, the transmitter and the receiver can be enabled when required using the following instructions:

```
SETB TEN                ; enable the transmitter
SETB GREN                ; enable the receiver
```


ize a network to meet a specified worst-case access time.

At first glance, you might think that you could tailor a network so that the nodes with the higher slot numbers would have lower access times than the nodes with lower slot numbers. After all, the slot counter decrements from a high count to a lower one. Consider the following worst-case scenario, though. The network is in a resolution phase and the slot counter is at a count equal to n . At this time, say, the node with an assigned slot number of $n+1$ receives an interrupt and wants to

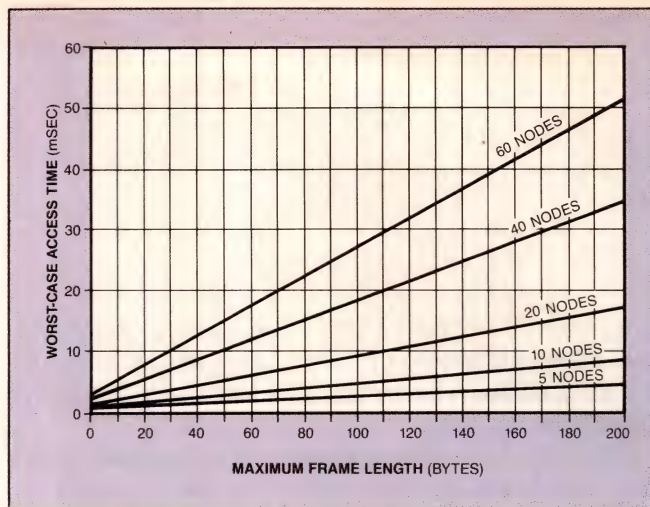


Fig 4—This graph plots the worst-case access time for a 2M-bps CSMA/DCR network having the same length, interframe space, and slot time as the one in Fig 3. As you can see, the worst-case access time varies according to the number of nodes and the maximum allotted frame length per node.

LISTING 2—SAMPLE CODE FOR THE 83C152's DMA CHANNELS

```

SETB DMA                ; select DMA to service transmitter (DMA
MOV DCON0, #88H          ; is a bit in TSTAT register)
                          ; select DMA channel 0 for transmitter,
                          ; DMA demand mode by serial channel and
                          ; external memory as source. The GO bit
                          ; is not set yet.
MOV DCON1, #29H          ; select DMA channel 1 for receiver, DMA
                          ; demand mode by serial channel and
                          ; external memory as destination. The GO
                          ; bit is set.
MOV SARH0, #10H          ; Source for channel 0 is memory
                          ; starting at
MOV SARL0, #00H          ; address 1000H
MOV DARH0, #00H          ; Destination for channel 0 is Transmit
                          ; FIFO
MOV DARL0, #85H          ; Transmit a count of 10 bytes
MOV BCRH0, #00H          ; Source for channel 1 is Receive FIFO
MOV BCRL0, #0AH          ; Destination for channel 1 is memory
MOV SARH1, #00H          ; starting at address 2000H
MOV SARL1, #0F4H         ; receive up to 64 bytes
MOV DARH1, #20H
MOV DARL1, #00H
MOV BCRH1, #00H
MOV BCRL1, #40H

```

Depending on the application, the transmitter and the receiver are enabled when required using the following instructions:

```

SETB TEN                ; enable the transmitter and then set
                          ; the GO
ORL DCON0, #01H          ; bit for the DMA to start
                          ; transmission.
SETB GREN                ; enable the receiver

```


There's no substitute for the quality
of our I-SIPs and I-DIPs

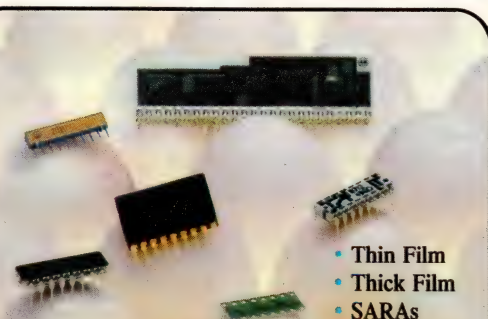
These rugged resistor networks feature a solid ceramic body and are superior performing networks. I-SIPs have triple-strength leads; low, medium and high profiles; 4, 6, 8 and 10 pins. I-DIPs also have solid ceramic body; low profile; 14, 16 and 18 pins. Both have large circuit design area and exclusive A-B Cermet ink, providing outstanding custom capability. CAD and SPC manufacturing. Call 800-592-4888 or 800-292-4888 in Texas or write . . .



ALLEN-BRADLEY

A ROCKWELL INTERNATIONAL COMPANY
1414 Allen-Bradley Drive, El Paso, TX 79936-6415

CIRCLE NO 15



- Thin Film
- Thick Film
- SARAs

We provide solutions for
dozens and dozens of applications

Bring Allen-Bradley in early. We've got 20 years experience in solving difficult resistor network problems. Broad range of thick film I-SIPs and I-DIPs, surface mount SARAs, precision thin film, and hybrid network substrates . . . all in standard or custom packages. Call 800-592-4888 or 800-292-4888 in Texas or write . . .



ALLEN-BRADLEY

A ROCKWELL INTERNATIONAL COMPANY
1414 Allen-Bradley Drive, El Paso, TX 79936-6415

CIRCLE NO 16



We cover the spectrum in custom
and standard panel and trimming pots

We've been making reliable Variable Resistors since the 1930's, and our quality is better than ever. If one of our standard pots doesn't meet your needs, we'll customize to suit your application. Call 800-592-4888 or 800-292-4888 in Texas or write . . .

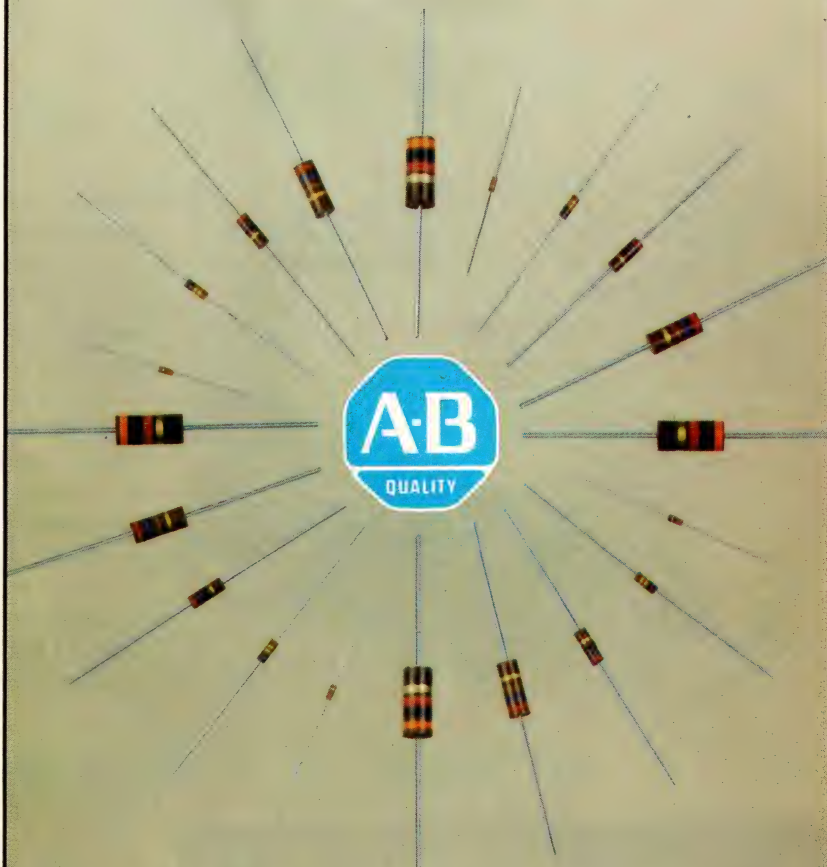


ALLEN-BRADLEY

A ROCKWELL INTERNATIONAL COMPANY
1414 Allen-Bradley Drive, El Paso, TX 79936-6415

CIRCLE NO 17

When quality counts, count on Allen-Bradley



**Our fixed carbon composition resistors
are performing in critical applications
with a reliability record that is
second to none.**

Allen-Bradley delivers these astoundingly reliable components on time, every time. We have been producing carbon composition fixed resistors for over 50 years and will be doing so for the next 50 years. This year we've instituted new programs to bring delivery to you "just-in-time".

Our resistors offer the ultimate in integrated circuit protection. They provide MIL-SPEC reliability, pulse withstanding power dissipation, high frequency stability and low inductance. In addition, Allen-Bradley resistors are recognized as the most reliable of all electronic components.

We have power ratings from 1/8 Watt through 4 Watts @ 70°C. Allen-Bradley hot-molded carbon composition resistors meet or exceed all applicable military specifications including MIL-R-39008 and are fully qualified in all wattage sizes and resistance values to the best reliability level (S) with a failure rate of 0.000073%/1000 hours.

Next time you make a fixed resistor buy, specify Allen-Bradley. We can deliver on time and would like to serve you. For more information call 800-592-4888 or 800-292-4888 in Texas, or write for Publication ROFR . . .



ALLEN-BRADLEY

A ROCKWELL INTERNATIONAL COMPANY
1414 Allen-Bradley Drive, El Paso, TX 79936-6415

CIRCLE NO 18

CUT THE COST OF FLEX-RIGID CIRCUITS IN HALF.

We've brought together two proven technologies: multilayer printed circuit hardboards and Sculptured® flexible circuits. The result? A highly reliable and cost effective alternative to flex-rigid for your high density applications.

Our **Modular Flex** assemblies offer you these advantages over standard flex-rigid:

- lower unit cost
- easy to assemble
- easy to repair
- lighter weight
- greater flexibility
- greater reliability

Want the details? Call or write:



Advanced Circuit Technology

118 Northeastern Boulevard
P.O. Box 547X
Nashua, NH 03061
1-603-880-6000
1-800-234-FLEX



CIRCLE NO 122

Should delivery of
JANTXV parts
take longer than
production of an
F15 Fighter?
(Not anymore.)

MIL-S-19500

We also carry
JAN and
JANTX
parts.

BKC, the world's largest manufacturer of Germanium Diodes, is now one of the largest manufacturers of Silicon Switching Diodes which meet MIL-S-19500G Detail Specification. Call us for more details.

1N914 / 116

1N4148-1 / 116

1N4150-1 / 231

1N4153-1 / 337

1N4454-1 / 144



BKC International Electronics Inc.

Tel. (508) 681-0392

Fax (508) 681-9135

Telex 928377

6 Lake Street • P.O. Box 1436 • Lawrence, MA 01841

CIRCLE NO 123

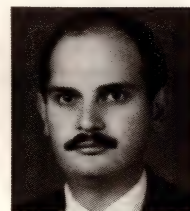
transmit immediately. Before the node can transmit, the current resolution phase must count out, and if by chance another collision occurs at the end of that phase, a new resolution phase must begin to decrement. The access time for the $n+1$ node would then be the worst-case calculated value.

Once you've determined your network's configuration, the 83C152 lets you establish network parameters easily. **Listing 1** shows the code that initializes the GSC to perform the DCR operation for a particular node. Programmable features of the GSC include the bit rate (from 2M bps with an internal baud generator to 2.5M bps with an external clock), the preamble bit pattern, multiple destination addresses, and the type of CRC bits. **Listing 2's** program shows how you can use the two DMA channels to service the GSC.

EDN

Author's biography

Deif N Atallah is a staff engineer with Intel's Embedded Operation Group in Chandler, AZ. He is currently responsible for the product architecture of 32-bit embedded controllers. He obtained his BSEE from Alexandria University, Egypt, and his MSEE degree from Penn State University. Deif enjoys world traveling, camping, and photography.



Article Interest Quotient (Circle One)
High 497 Medium 498 Low 499

SIEMENS

Ready-made or made-to-measure?

Siemens ferrites are the right fit.

You choose which design meets your requirements best.

Ready-made ferrites? Siemens offers a wide range of standard power, transformer and filter ferrites covering

- pot and RM cores
- E/U cores
- toroids
- small accessories

If you wish, you can have complete inductor sets including coil formers, insulating washers, clamps and mounting assemblies. Magazine and tape packaging permits automated handling by winding and assembly machines, enabling you to concentrate your time and money on other tasks.

You'd prefer made-to-measure ferrites? For the individualists among you we produce ferrites customized

in shape, material and size. That way we are able to provide you with any inductor you require and satisfy your demand for innovative electronics. Just to mention ISDN or custom SMD solutions.

If you want to find out more, write Siemens AG, Infoservice 12/Z065, Postfach 23 48, D-8510 Fürth quoting "Ferrites and accessories".

TopTech Components:
Siemens



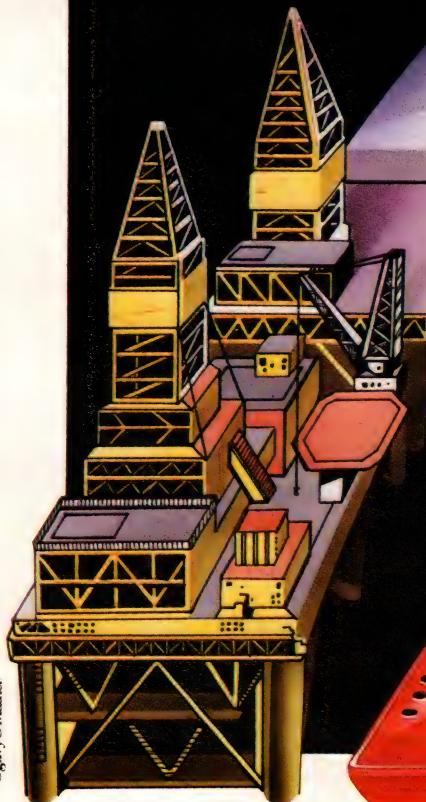
CIRCLE NO 124

12/Z065e



Argentina
 Buenos Aires
 (01) 541-7141 to 7747
Australia
 Artarmon, N.S.W.
 (02) 439 3322
Austria
 Wien
 (0222) 60101-820
Belgium
 Bruxelles
 (02) 525 61 11
Brazil
 Sao Paulo
 (011) 211-2600
Canada
 Scarborough
 (416) 292-5161
 Signetics Etobicoke
 (416) 626-6676
Chile
 Santiago
 (02) 77 38 16
Colombia
 Bogota, D.E.
 (01) 2 49 7624
Denmark
 Copenhagen
 (01) 54 11 33
Finland
 Helsinki
 (90) 172 71
France
 Issy-Les-Moulineaux,
 Cedex
 (01) 40 93 80 00
Germany
(Fed. Republic)
 Hamburg
 (040) 3296-0
Greece
 Tavros
 (01) 48 94 339/4894 911
Hong Kong
 Kwai Chung
 (0)-24 51 21
India
 Bombay
 (022) 4930311/4930590
Indonesia
 Jakarta
 (021) 5179 95
Ireland
 Dublin
 (01) 69 33 55
Italy
 Milano
 (02) 6752.1
Japan
 Signetics Japan Ltd.
 Tokyo (03) 230-1521
Korea (Republic of)
 Seoul
 (02) 794-5011
Malaysia
 Pulau Pinang
 (04) 87 00 44
Netherlands
 Eindhoven
 (040) 78 37 49
New Zealand
 Auckland
 (09) 605-914
Norway
 Oslo
 (02) 68 02 00
Pakistan
 Karachi
 (021) 72 57 72
Peru
 Lima
 (014) 707080
Philippines
 Makati-Rizal
 (02) 86 89 51 to 59
Portugal
 Lisboa Codex
 (019) 68 31 21
Singapore
 Singapore
 35 02 000
South Africa
 Johannesburg
 (011) 402-4600/07
Spain
 Barcelona
 (03) 301 63 12
Sweden
 Stockholm
 (08) 7821 000
Switzerland
 Zurich
 (01) 488 22 11
Taiwan
 Taipei
 (02) 7120500
Thailand
 Bangkok
 (02) 233-6330-9
Turkey
 Istanbul
 (01) 143 59 10
United Kingdom
 London
 (01) 580 6633
United States
 Signetics Corporation
 Sunnyvale
 (408) 991-2000
Uruguay
 Montevideo
 (02) 98 53 95
Venezuela
 Caracas
 (02) 239 39 31

Philips microcontrollers make your ideas work better.



Ogilvy & Mather





Philips single-chip 8-bit microcontrollers help turn your product ideas into commercial reality as quickly, easily, and economically as possible.

You can work with CMOS, NMOS or bipolar microcontroller families incorporating a comprehensive list of derivatives. These are backed by a wide range of I²C-bus peripherals to help implement your design. And we've made it as easy as possible to choose the right microcontroller for your application. We provide a choice of 64 to 256-byte RAM, 1K to 16K ROM, on-board functions like ADC, EPROM, timers and I²C-bus interface. We offer bond-out and EPROM versions and you can also select from a variety of industry standard packages; DIL, SO, PLCC, QFP or PGA – with temperature ranges as broad as -40°C to 110°C.

Philips, Europe's leading manufacturer of 8-bit microcontrollers, is a major force in electronics world-wide. When your partner is Philips you can move more confidently and effectively from ideas to reality.

For your copy of the latest Philips 8-bit microcontroller brochure, contact your local Philips organization (see left) or complete the coupon and send it to:

Philips Components Division, Building BA,
P.O. Box 218, 5600 MD Eindhoven,
The Netherlands.
Telex: 35000 phtc nl/nljvmc.

Please send me the Philips single-chip 8-bit microcontroller brochure

Name _____

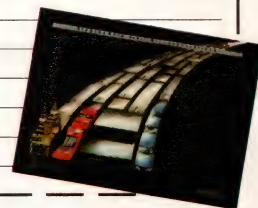
Position _____

Company _____

Address _____

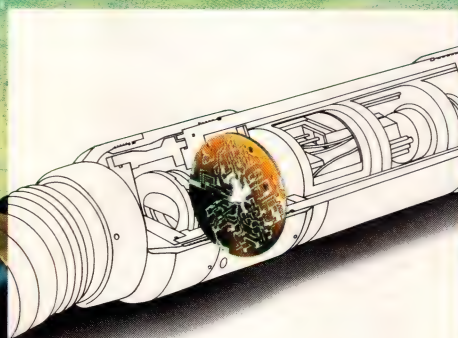
Tel _____

EDN081888



single-chip 8-bit microcontrollers.
The name is Philips.

There are no repairmen at 4,000 fathoms.



So we build our hybrid ICs to last. Almost forever. In fact, our hybrid ICs are some of the most reliable components in a new fiber optic submarine repeater with a theoretical working life of 1,500 years!

We've been making ultra-reliable hybrid ICs since 1967. In those 20 years, we've created more than 1,000 different hybrid IC designs. And many of our best ideas have ended up in telecommunications applications where small size and



high reliability are essential. Like PBX systems, telephone and radio systems.

Today Fujitsu is a leader in IC design and the world's largest manufacturer of application-specific ICs (ASICs). Using thick-film, thin-film and T² (thick-thin) technology, we can give you the right combination of high circuit density and high stability for each application.

When you need hybrid ICs for telecommunications systems, call the company that's been a reliable source for over 20 years.

CIRCLE NO 126

FUJITSU MIKROELEKTRONIK GmbH:

Arabella Center 9, OG./A, Lyoner Straße 44-48, D-6000 Frankfurt am Main 71, F.R. Germany Phone: 069-66320 Telex: 0411963 Fax: 069-6632122

FUJITSU COMPONENT OF AMERICA, INC.:

3330 Scott Blvd., Santa Clara, California 95054-3197, U.S.A. Phone: 408-562-1000 Telex: 910-339-0190 Fax: 408-727-0355

FUJITSU MICROELECTRONICS PACIFIC ASIA LIMITED:

805, Tsim Sha Tsui Centre, West Wing, 66 Mody Road, Kowloon, Hong Kong Phone: 3-7320100 Telex: 31959 FUJIS HX Fax: 3-7227984

FUJITSU LIMITED (Electronic Components International Sales Support Div.):

Furukawa Sogo Bldg., 6-1, Marunouchi 2-chome, Chiyoda-ku, Tokyo 100, Japan Phone: National (03) 216-3211 International (Int'l Prefix) 81-3-216-3211 Telex: 2224361 Fax: (03) 216-9771

FUJITSU

"OUR THIRD-PAGE ADS IN EDN MAGAZINE AND EDN NEWS PULL BETTER THAN OUR OTHER ADS ELSEWHERE."

Charles E. Altschul
Vice President, Marketing
Modutec Inc.

Chuck Altschul can say that with authority.

As vice president of marketing at Modutec Inc., a manufacturer of analog and digital panel meters, he has set up a lead tracking system with Inquiry Technology of Rhode Island. The system tells him precisely which ads work best.

"It's right there in black and white: 18% of our leads come from EDN magazine and EDN News, and the highest percentage of sales also comes from them.

"In fact, our Big-Little™ DPM production has increased ten-fold. Much of the increase is attributable to our consistent advertising program in the two publications."

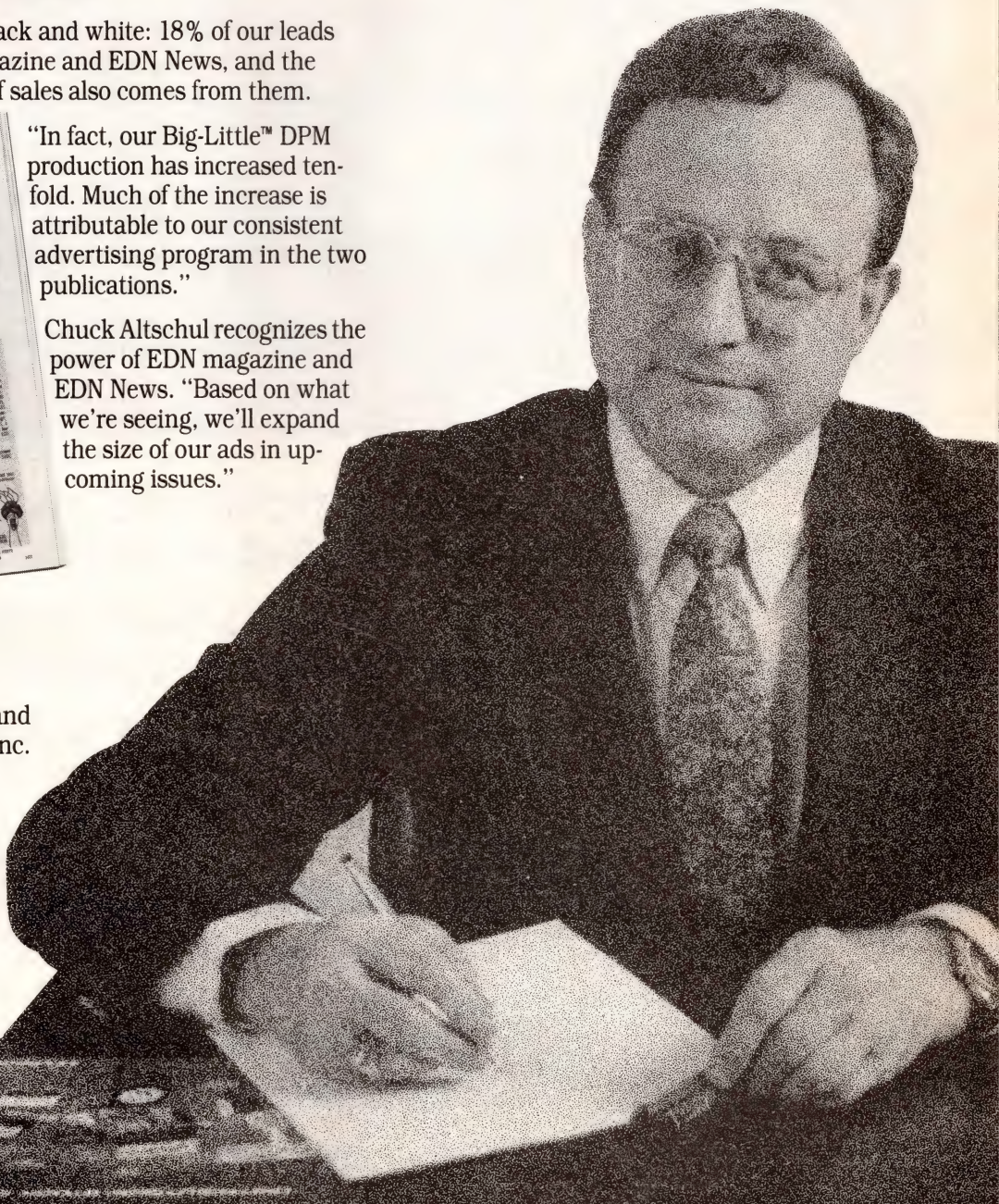
Chuck Altschul recognizes the power of EDN magazine and EDN News. "Based on what we're seeing, we'll expand the size of our ads in upcoming issues."



Advertising in EDN magazine and
EDN News works for Modutec Inc.
It can work for you.

EDN

Where Advertising Works



MILITARY POWER SUPPLIES — FULL MIL-SPEC

- High Performance
- High MTBF
- High Efficiency
- High Density
- Fixed Frequency Conversion



STANDARD CUSTOM DC/DC, AC/DC
UP TO 10KW SINGLE AND MULTIPLE OUTPUTS

Our Large Engineering Team Is Ready
For Your Toughest Requirements

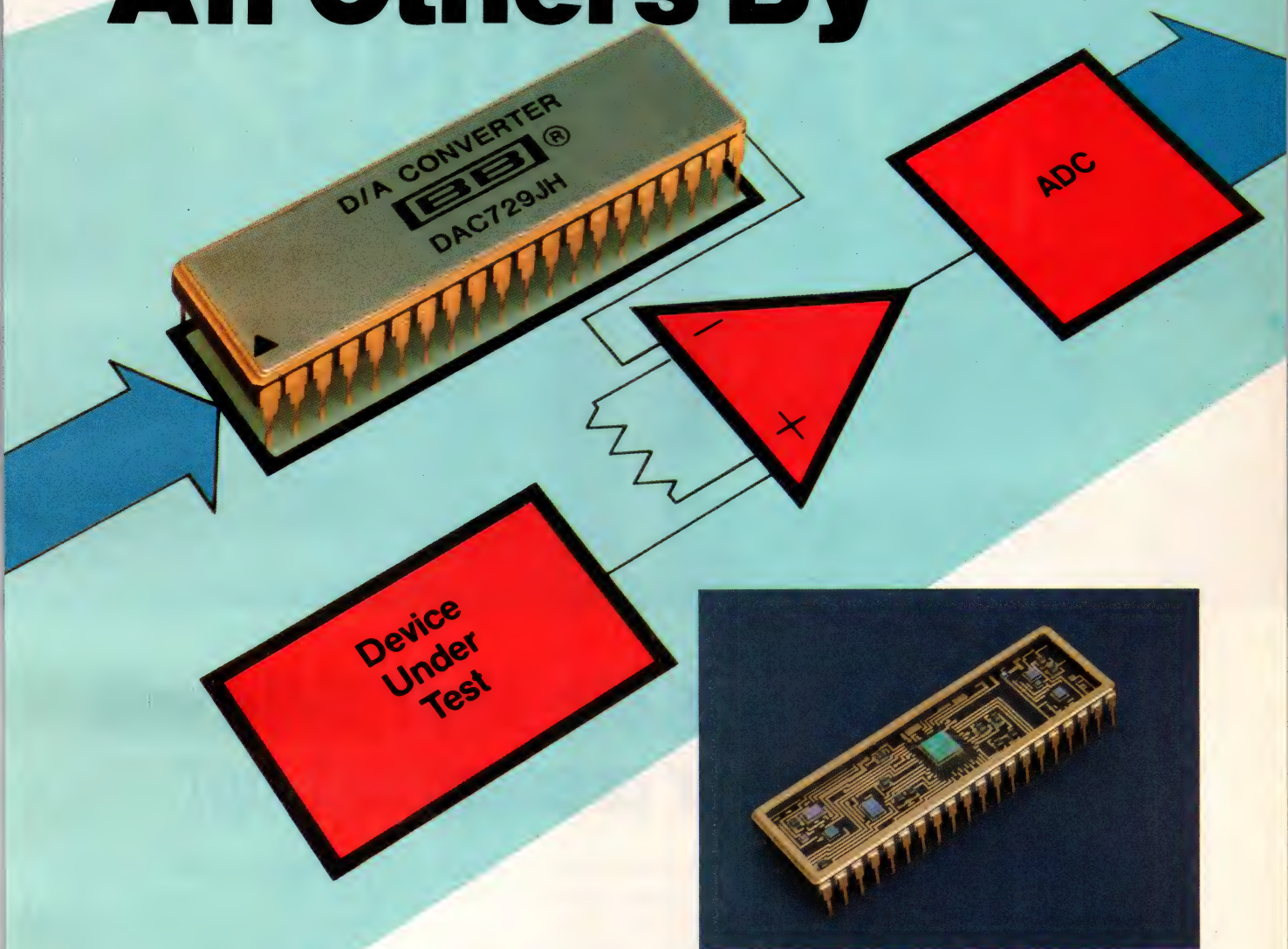
For further information call or write:

MPS MILPOWER SOURCE, INC.

P.O. Box 657
Belmont, N.H. 03220
TEL: (603) 267-8865
FAX: (603) 267-7258

NEW 18-BIT DAC729

The DAC To Measure All Others By



This 18-bit D/A converter sets new standards for resolution, accuracy, and dynamic range.

Originally designed as a programmable ATE reference, DAC729's exceptional accuracy and stability also make it an excellent choice for digital audio, precision controller, and precision waveform generator applications. Consider these features:

- 18-bit resolution
- $\pm 0.00076\%$ FSR max linearity error
- complete with 10V reference, precision output op amp
- $\pm 5\text{ppm } ^\circ\text{C}$ max gain drift (exc. ref.)
- $8\mu\text{s}$ max settling time to $\pm 0.00076\%$ FSR
- $I_{\text{OUT}} (\pm 1, 0 \text{ to } -2\text{mA})$ or $V_{\text{OUT}} (\pm 2.5, \pm 5, \pm 10, 0 \text{ to } +10, 0 \text{ to } +5\text{V})$
- 40-pin hermetic DIP

Put the new DAC729 to your test now. Call your Burr-Brown representative or Applications Engineering, 602/746-1111, for full details. Burr-Brown Corp., P.O. Box 11400, Tucson, AZ 85734.

BURR-BROWN®
BB

WARNING



WARNING: This 8½ digit DMM will replace your present set-up!

You have been warned... the Model 1281 from Datron is so good, it's hard to resist!

The 1281 is the world's most advanced DMM of its kind; bringing you the ultimate in electrical measurement via its accuracy, functional capability and ease of use.

Take advantage of user selectable resolutions up to 8½ digits backed up by accuracies and repeatabilities to suit the longest scale length. And DCV performance from 10nV to 1000V with 1 year specifications to ± 3 ppm, coupled with true RMS ACV providing 1 year accuracies of ± 80 ppm. High accuracy resistance, current and ratio measurements are also yours with this superb instrument.

At the touch of a key, Selfcal, Datron's unique, accurate method of internal calibration enhances the impressive instrument specifications while providing excellent performance outside controlled temperature environments. This exclusive Datron feature also provides a very comprehensive self test.

If that's not enough to change your present set-up consider High Accuracy Spot Frequency ACV, Low Current Resistance measurement for resistance thermometry and simultaneous Frequency and RMS ACV. The 1281 incorporates menu control which makes it easy to operate and built in as standard is IEEE-488.2, the way forward for test and calibration systems.

For more information, call us today. Our fact filled 1281 brochure will take you through, detail by detail, specification by specification, the world's most advanced DMM.

United States:
San Diego, Cal. (619) 565-9234
Clearwater, Fl. (813) 797-1792
Beech Grove, Ind. (317) 787-3915
Suffern, N.Y. (914) 357-5544

United Kingdom:
Norwich (0603) 404824



Testability is crucial in PLD-circuit design

Compared with standard logic parts, PLDs tend to have higher defect rates and require a larger investment in test-program development. As a result, engineers must make testability a prime design goal to ensure that the final product can be manufactured and tested economically.

Peter de Bruyn Kops, *Anvil Software*

In increasing numbers over the past few years, board designers have felt the lure of PLDs. Two basic reasons underlie the devices' popularity. One, PLDs are much more powerful than 7400 Series TTL parts and, two, they are much easier to troubleshoot than gate arrays. A logic error found in a PLD prototype board in the morning can often be fixed by that afternoon—something that gate-array users can only dream of. Today, it's not uncommon for a board to contain 50 or more PLDs.

PLDs do require more test-development effort than standard TTL parts, however, and the reason for this is also quite basic. In standard-logic design, the test department creates a test program, puts it in a library, and then reuses it many times over the years. The test

engineers have easy access to all the standard logic-test programs they need. A PLD test program, in contrast, is not reusable. A 16L8 PLD design test program, for example, is good for only one particular design; any other 16L8 design will require a different test program.

The rationale for testability

To make it worthwhile to design with PLDs, therefore, you have to design with testability in mind and ensure that the test department can test your circuits within a reasonable length of time and for a reasonable expenditure. A PLD is not very testable if it requires a million dollar tester that holds 1 million vectors. A PLD is also not very testable if it takes a genius three weeks to develop an adequate test. For a board with 50 PLDs, a realistic prediction of test-development time is less than a day per device—except in the highest volume manufacturing operations. Simply stated, the effectiveness of the test engineers is inversely related to the sophistication of your design.

For the purposes of this article, assume that your test engineers have been blessed with good documentation and an automatic test-vector generator (ATG) that can create tests for a variety of combinatorial and sequential PLD designs. By comparing the following untestable or difficult-to-test circuits with their enhanced-for-testability counterparts, you will achieve an understanding of how your design practices will hinder or help subsequent testing of the devices. If you decide

A designer's interests are best served when the test engineers have good documentation and a state-of-the-art automatic test generator.

to heed these design tips, you'll decrease manufacturing time and costs and shorten test-development time—and you may also win some friends in the test department.

Oscillator circuits create problems

Oscillators are easy to create with a PLD (Fig 1a), but testing a PLD-based oscillator isn't so straightforward. Whereas PLD testers can readily strobe settled states, oscillator circuits typically require testing of their test frequency and duty cycle. At best, a PLD tester will find such a task difficult, and for many PLD testers it's impossible.

An ATG cannot usually handle an oscillator. Even worse, the oscillator may interfere with the automatic-test generation for other parts of the design. If you want to develop a PLD-based oscillator, you should add an Enable signal so that you can turn the oscillator off (i3 in Fig 1b). Optimally, the Enable signal should be on a dedicated pin. In addition, try to add extra logic, which will allow you to stabilize the oscillator output in both the one and the zero states. This capability will expedite parametric testing.

PLD-based pulse, or glitch, generators (Fig 2a) are just as troublesome to develop tests for as are oscillators. Without proper communication between the design and test departments, the test engineer will have no way of knowing whether the detected signal transition is a legitimate generator output or a system glitch.

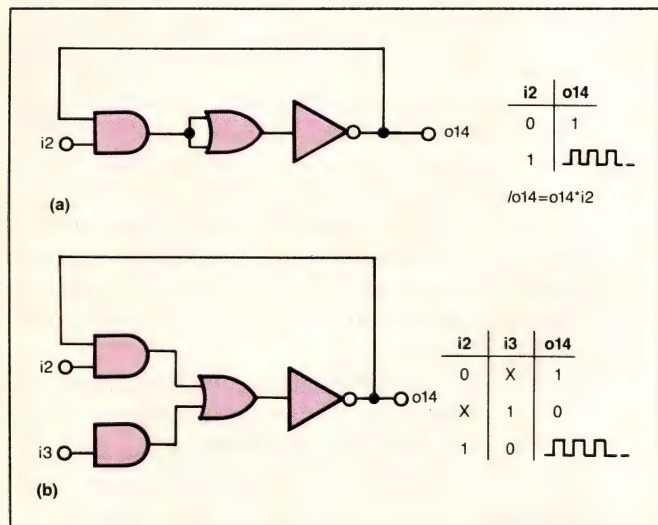


Fig 1—Although it's easy to create oscillators with PLDs (a), the testers commonly used for PLDs cannot easily evaluate the performance of an oscillator. If you redesign the circuit and add an Enable signal (i3), the oscillator can be turned off during testing (b).

If the pulse is indeed a legitimate output, the test engineer will have to develop a special test program and use a more expensive tester to determine that the pulse does indeed occur and that it has the right width.

ATGs typically cannot accommodate glitch generators. And again, the glitch generator may interfere with the automatic-test generation for the rest of the board. As before, try to include additional logic (Fig 2b) that will stabilize the generator output (to both the one and the zero states) to facilitate parametric testing.

Meeting the demands of in-circuit testers

If your PLD design relies on feeding outputs back to inputs on the circuit board, watch out that you don't complicate in-circuit board testing. Depending on how the PLD connects to other devices on the board, external PLD feedback may compound the problem of testing the rest of the board.

Testing the PLD itself may also prove difficult, depending on the ATG's software and the source of any other vectors. If the ATG assumes that two pins can

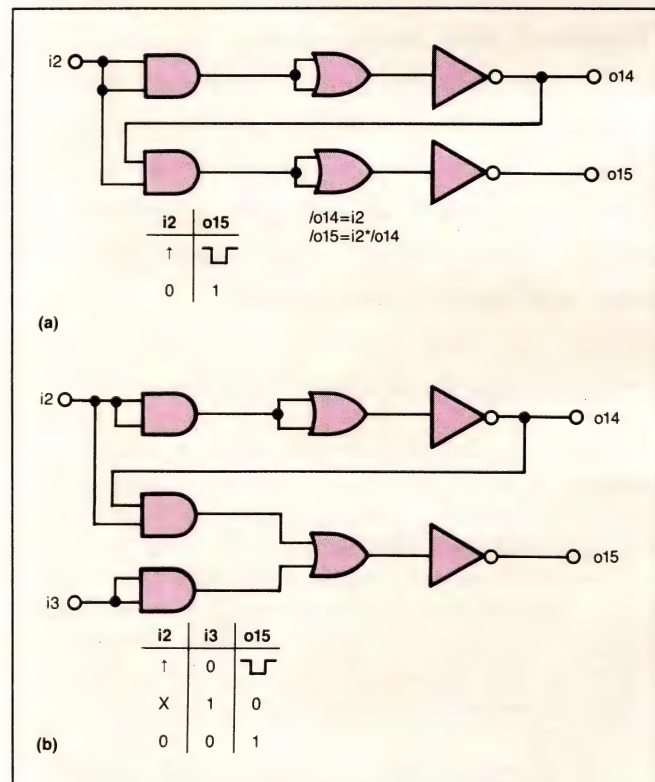


Fig 2—Automatic test-vector generators (ATGs) usually are incapable of testing pulse generators (a). The pulse generator can also hinder the ATG's capability to test other circuitry on the board. By adding logic (b), you can stabilize the generator's output.

Most PLD-based designs seem to always hard-wire any 3-state outputs in the on condition, thereby creating problems for in-circuit test systems (**Fig 3a**). A test engineer writing an in-circuit board test program will normally prefer to turn a 3-state output off and drive that output point with the tester. If the output is always on, the test engineer may need to overdrive the pin. Overdriving complicates the test and may make the test more difficult to debug. You can circumvent these problems by controlling all 3-state outputs with an Enable signal (i9 in **Fig 3b**).

The exception to this rule are memory elements with 3-state outputs. Memory elements created by feedback around a 3-state type of combinatorial output introduce

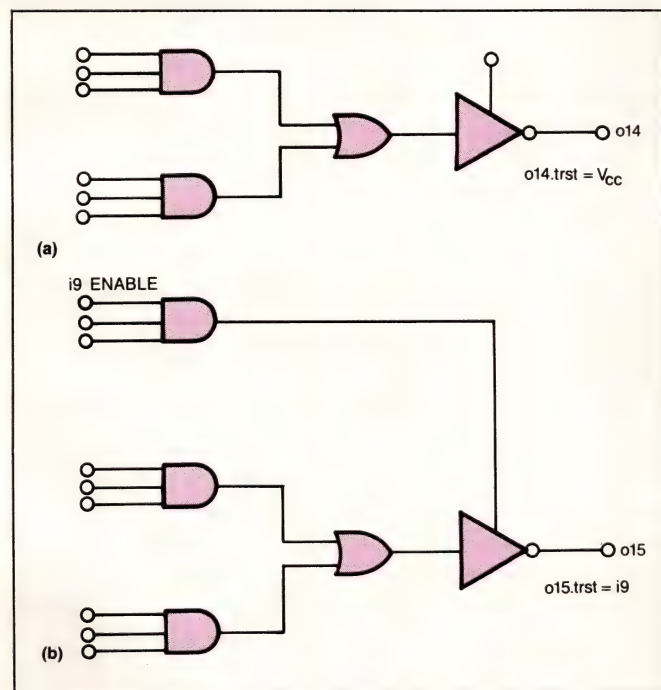


Fig 3—The majority of PLD-based designs pose problems for in-circuit testing (a). You must control 3-state outputs with an Enable pin if system performance is going to be evaluated using in-circuit testing techniques (b).

During functional testing and with bipolar parts, this dual-drive condition isn't usually a problem, but it may prove troublesome with some CMOS devices. Moreover, even some good parts might fail if the tester performs an input-leakage test on that pin for that test vector. Many PLD testers automatically perform input-leakage tests when they initially drive a pin high or low.

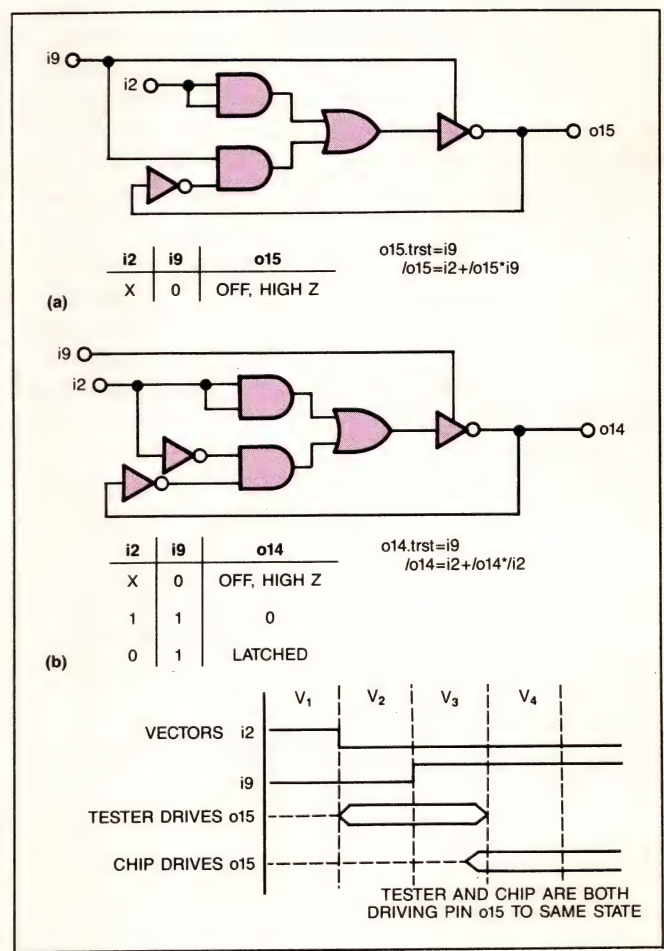


Fig 4—When you create a memory element by using feedback around a 3-state type of combinatorial output (a), you introduce special testing subtleties. If you remove i9 from the feedback path (b), the circuit will be much more testable.

A memory element created by feedback around a 3-state type of combinatorial output introduces some special testing subtleties.

If the PLD is driving the pin at this time, the test engineer will have to manually modify the test.

To avoid the simultaneous-drive situation, the test engineer can write the vectors so that they turn the tester driver on o15 off at the same time that i9 goes high. On most PLD testers, this action causes a race condition and may produce intermittent failures of good parts. If the engineer uses an expensive tester, it will turn the chip drive to o15 off a specified number of nanoseconds after i9 goes high and eliminate the race problem, but it will also require that the test engineer take special effort to modify the test program.

To make the circuit in Fig 4a more testable, you can modify the design to remove i9 from the feedback path (Fig 4b). Once you make this change, the 3-state operation is independent of memory operation.

Complex memory elements are created either by building a feedback loop containing more than one output or by overlapping two feedback loops, and they pose their own peculiar problems (Fig 5). In general, ATGs (as well as test engineers) have difficulty figuring out how to operate complex memory elements, and therefore the circuitry inside the elements is less likely to undergo an adequate test. Complex memory elements are also likely to produce races on the tester, even if they don't race in the final circuit application. These race conditions develop because the vector writer does not fully understand how to operate the circuit correctly. In the case of complex memory elements, therefore, close cooperation between the design and test departments is essential.

Designs that cannot be initialized are difficult to test,

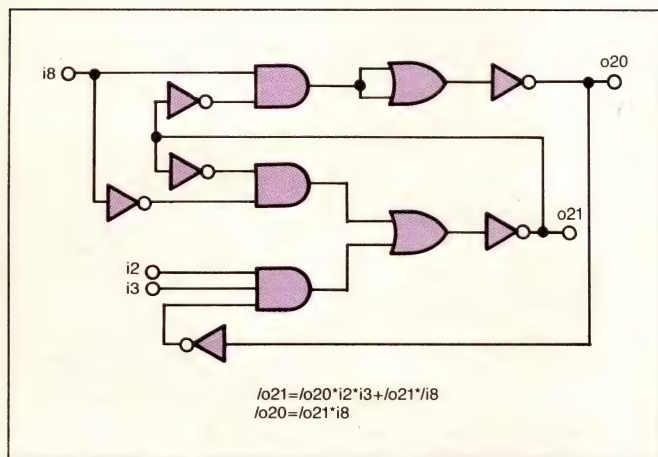


Fig 5—Complex memory elements are tough to test thoroughly because it's difficult for the test engineer—and the automatic test generator—to figure out how to operate the elements.

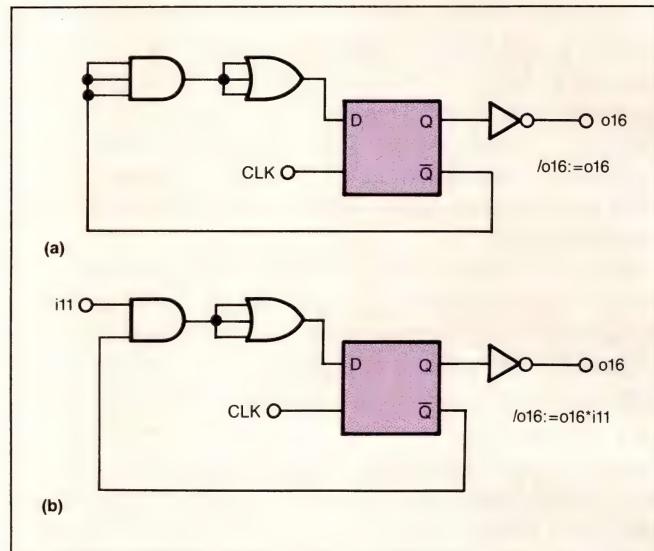


Fig 6—Although circuits that cannot be initialized are fairly common, they are very difficult to characterize (a). The modified flip-flop circuit of b is much easier to test.

but unfortunately such circuits constitute 10%—or more—of existing PLD designs. The toggle flip-flop of Fig 6a is a good example of a simple, common circuit that cannot be initialized. A test program needs to first initialize the device and then test it. If an ordinary sequence of vectors cannot initialize the device, the test engineer has to choose from three options, all of which unfortunately present some problems.

First of all, the test engineer can synchronize the tester to the part. A typical synchronizing scheme loops the test on one or more vectors until the output pins match predefined states. Not all testers have this capability, though, and some testers that do are limited to looping on one vector only. To use this match mode (as some tester manufacturers call it), the engineer has to determine which vectors to loop on.

The second option relies on the device's power-up state. Many of the PLDs available today power-up with the register bits either all high or all low. Because vendors of PLDs have not standardized the power-up state, PLD users who regularly mix sources need different test programs for each vendor—a logistical nightmare. Also, if the device contains memory created by feedback around a combinatorial output, the memory element cannot be initialized: There's no way to reliably know its power-up state. Another problem will surface if the device or the tester requires substantial time (100 msec or more) to power-down and power-up the device. A test that checks parameters (dc or ac) has



If indicator lights look like this to you, look away.

Perhaps it's the brilliant colors. Or the sparkle of chrome. Somewhere along the way, the people who buy, and even the people who build indicator lights have come to think of them as little more than ornamentation.

Dialight disagrees. The way we see it, an indicator light might be the only way of knowing a critical system is on, off, up, down, hot, cold, dead or alive. An attitude you can see in every model of our incredibly wide selection.

Take our sub-sub-miniature incandescents, for example. Each fitted with a high reliability filament lamp enclosed in a high-impact, plastic cap. The lens is molded directly to the mounting bushing for added strength. The entire assembly is available in a wide variety of colors and meets the requirements of MIL-L-3661B.

With caps constructed of lexan to survive high-heat lamps, we've engineered indicators for continuous usage at levels to 250V.

And to provide operation at a specific voltage level while preventing instantaneous burnout, our neon indicators are ballasted with integral current limiting resistors.

We've even designed a line of ultra-miniature incandescent and neon indicators with plug-in replacement cartridges that make changing lamps a snap.

Incandescents, neon and LED indicators available in a virtually limitless range of colors, sizes, configurations and mounting styles. In fact no one makes more indicator lights for more applications than Dialight. Even designs that meet MIL-L-85762A night vision requirements and other military specifications.

If you're starting to look at indicator lights the way we do, we suggest you continue to do so in our catalog. It's available free by dialing 201-223-9400. Or by writing; Dialight Company, 1913 Atlantic Avenue, Manasquan, NJ 08736.



DIALIGHT COMPANY A Division of
North American Philips

DIALIGHT • KULKA • HHSMITH

Engineering is the only commodity we sell.

FEATURES

10ps Delay Resolution
2.5ns to +100µs Full Scale Range
Differential Inputs
Separate Trigger and Reset Inputs
310mW Power Dissipation

APPLICATIONS

ATE
Pulse Deskewing
Phase Correction
High Stability Timing Circuits
Waveform Generators

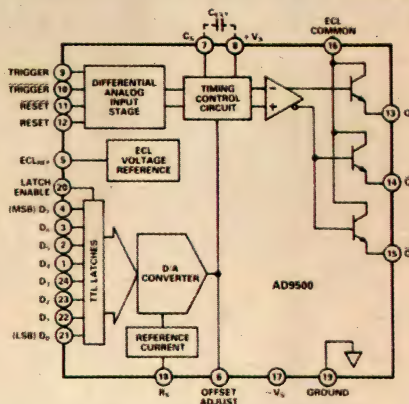
PRODUCT DESCRIPTION

The AD9500 is a digitally programmable delay generator which includes virtually all the circuits needed for generating time delays for digital pulses. It provides 256 programmed delays in a user-specified full scale range which can be varied from more than 100µs to as little as 2.5ns. On the latter scale, it can resolve increments as small as 10 picoseconds.

Its output is delayed from the input by a time which is directly proportional to the 8-bit digital input code. Using groups of AD9500 devices is an excellent way to adjust signal timing skews and delays in various system applications.

Differential TRIGGER and RESET control inputs are designed primarily for ECL signal levels but will also function with analog and TTL levels. An on-board ECL reference midpoint allows both to be driven by either single-ended or differential ECL circuits.

Two temperature ranges and three packages are available. For industrial temperatures of -25°C to +85°C, order the AD9500BP or the AD9500BQ. The "P" suffix indicates a 28-pin PLCC; the "Q" designates a 24-pin ceramic "skinny" DIP with 0.3" package width. For extended temperatures of -55°C to +125°C, order the AD9500TE (28-pin LCC) or AD9500TQ (24-pin "skinny" DIP).

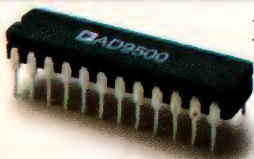


AD9500 Functional Block Diagram

PRODUCT HIGHLIGHTS

1. The AD9500 delay generator is an extremely versatile but remarkable, easy-to-use timing device. A few basic configurations can be expanded and extended into multiple applications.
2. Accurate control of pulse timing is critical for all digital electronic systems, and many systems require that delays be controlled digitally. Until now, the majority of systems using that technique used discrete LSI devices which may consume up to one watt or more of power. The AD9500 performs the same function with 300mW of power.
3. Like a high speed counter, the AD9500 can be programmed with a binary digital word. This makes the unit a variable delay device, in effect, a digital-to-time converter (DTC). The digital input word scales the time reference of the AD9500 in essentially the same way a digital word scales voltage or current references in a DAC.

**TO SAVE HOURS
IN DIGITAL TIMING DESIGN, SPEND
A FEW MINUTES ON THIS PAGE.**



If you can't afford to spend hours designing and testing your own time delay circuits, then take a few minutes to learn about our new AD9500 monolithic time delay generator. It combines all the

functions you need to generate time delays for digital pulses on a single chip, so all you have to do is specify and order.

This unique, one-part solution also helps conserve board space and power, since the AD9500 is available in skinny 24-pin DIP or 28-pin LCC or PLCC packages, and dissipates only 310mW.

But its small size and low power consumption don't mean low performance. The AD9500 allows you to use an 8-bit TTL control word to select any one of 256 delay increments in a full-scale range of 100µs to 2.5ns. At the low end, you can resolve delays to 10ps.

And the AD9500 comes in the standard industrial temperature range of -25°C to +85°C, or an extended range of -55°C to +125°C.

In addition, the AD9500 is ECL compatible and usable with analog as well as TTL input levels. These features make it ideal for adjusting cable delays in multichannel ATE systems, or phase correction and timing generation in radar/ECM.

The AD9500 is not only quick to help you with your designs, it's quick to save you money, too. In fact, it's the lowest-priced time delay generator available.

With the AD9500, you won't have to waste another minute on time delay generation. So don't delay - call your nearest Analog Devices sales office soon.

to run the vectors many times and therefore will need the power-up state to initialize each of these vector runs.

The third option is preloading. Many of today's PLDs support a preload feature that allows the test engineer to apply special voltages (10 to 13V typically) to some output pins. Preloading temporarily converts the output pins to input pins to directly set the internal-register states. The test engineer will encounter several problems with preloading: Each PLD manufacturer has a different protocol; many testers cannot support preload voltages; preloading is incompatible with in-circuit testing because the high voltages can damage other parts; and parametric measurements often are not reliable immediately after preloading.

You can make some of these problems tolerable for the test department if you set the initial state by preloading only on the first vector. However, most test departments prefer not to use preloading for initialization. Some ATG packages will accept starting-state data and generate the test starting from that point. These types of packages allow the test engineer to obtain some valid test data, but they also mean that more vectors have to be generated and they also necessitate more computer time. The increased number of vectors may increase test times, or it may reduce test coverage if the tester cannot hold that many vectors.

The best way to circumvent all of the above problems and improve the testability of a design that can't be initialized is to devote an unused input or combination of inputs to load the initial state (**Fig 6b**).

Difficult-to-initialize designs also pose problems when it comes time to create test vectors, but they do not cause problems with the tester itself. For example, the following specification describes a particularly difficult-to-initialize design: "When you clock the circuit 10 times, it will wind up in a known state, but the states prior to the tenth clock will be unknown." This type of circuit, where a combination of unknown states is supposed to produce a known state on another gate, mainly causes problems with logic simulators. You can eliminate testability problems resulting from difficult-to-initialize designs in the same manner as circuits that cannot be initialized at all.

Sequentially deep designs cause test difficulties for two reasons. They require a large number of test vectors, and they stipulate that either the test engineer or the ATG software spend a lot of time developing such vectors. A 10-bit counter that can be cleared and then counts up is a good example of a sequentially deep

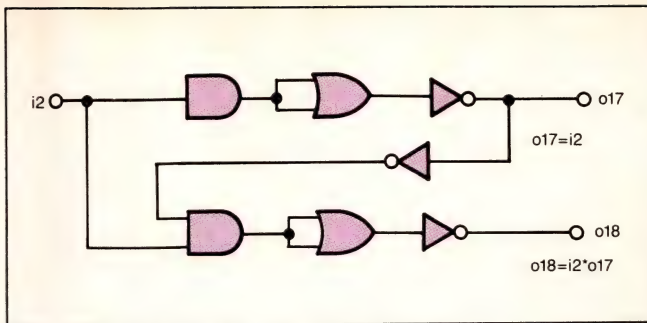


Fig 7—Circuit designers can, with good reason, design in time-sensitive redundancies to achieve a fault-tolerant design. Such designs can prove problematical for test engineers.

design. If a test engineer has to evaluate this part with a tester that is capable of holding only 512 vectors, test coverage will suffer. From the test department's point of view, the best solution is to modify the counter design so that it can be loaded with an arbitrary state. The ATG will then be capable of adequately testing it.

On some testers, sequentially deep designs can also limit the accuracy of ac measurements. These types of testers are most accurate when the transition they must measure occurs within a few vectors of the initialization point. In the 10-bit counter example from above, transitions in the high-order bits occur hundreds of vectors after initialization, which reduces timing accuracy. In a loadable 10-bit counter, these testers can accurately evaluate the transition from count 511 to count 512 with a few vectors by loading count 511 and clocking once.

Watch out for redundancies

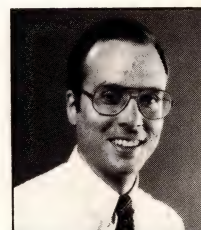
Time-sensitive redundancies are another cause of difficulties in testing because test generators and test engineers do not know if they should test the time-sensitive behavior. In ordinary cases, faults in the redundant logic are undetectable (that is, they are faults that cannot affect circuit operation), and some ATG packages can automatically filter them out (**Fig 7**). Obviously, if the fault can't affect circuit operation, there's no need to test for it.

These fault-tolerant circuits can prove very beneficial in some applications. If you choose to use such a circuit in your next PLD design, make sure you document the redundancy so the test engineer knows that he doesn't have to struggle with it.

EDN

Author's biography

Peter de Bruyn Kops is director of engineering at Anvil Software (Nashua, NH). In this position, he is responsible for developing programmable-logic test generators. Peter hold a Bachelor of Arts degree and a Masters in Science degree from Harvard College.



Article Interest Quotient (Circle One)
High 488 Medium 489 Low 490

It takes quite a computer to design a computer.

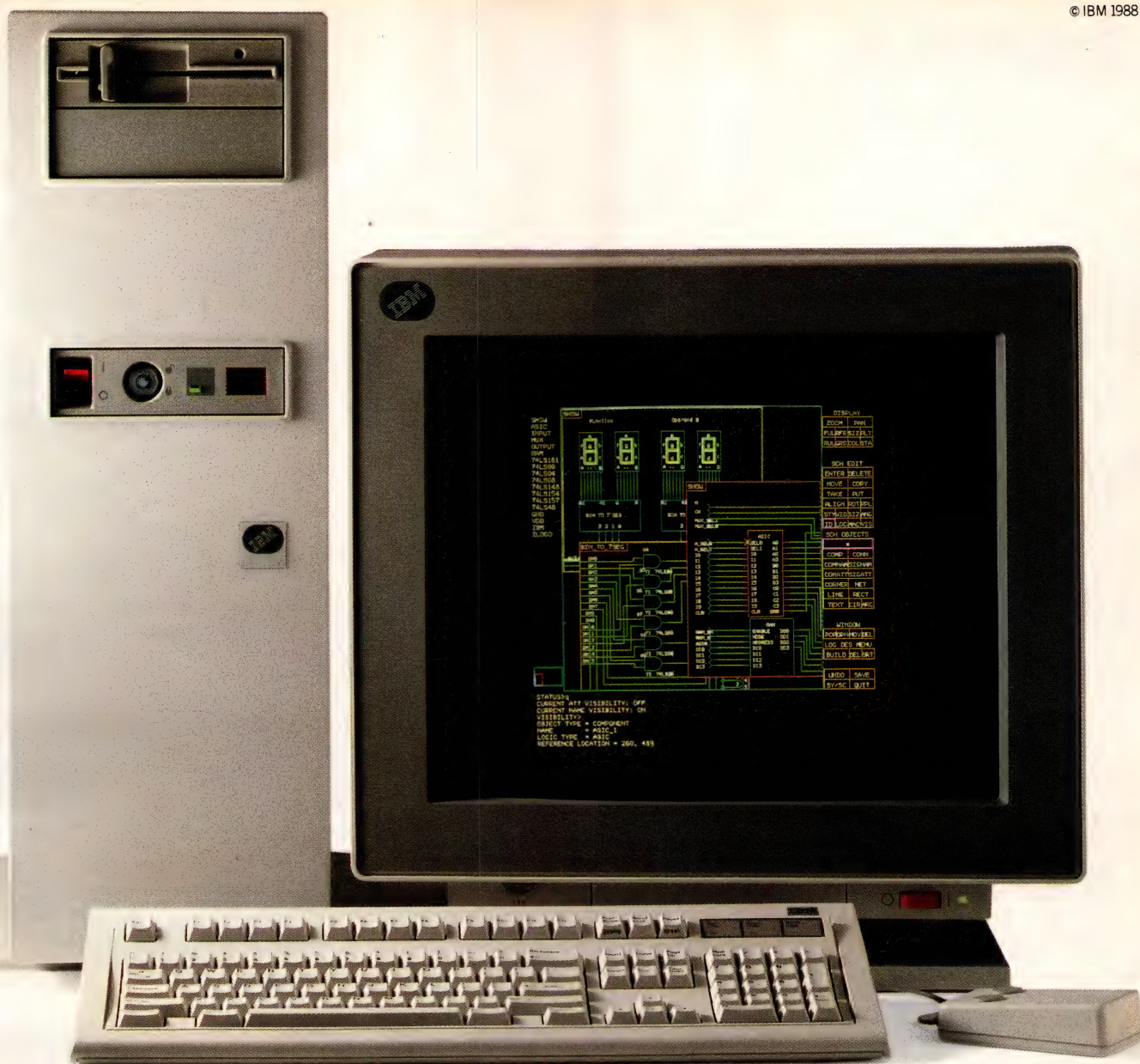
When IBM design engineers need a workstation to design the future, they turn to the IBM RT™ system for developing everything from circuits to software.

More and more commercial users are also recognizing that the RT's power, enhanced connectivity, extensive application library, outstanding graphics and low price make it the system-of-choice to build on. Medical practices, bridge builders and retail chains are among those that have already put the RT to work.

The IBM RT is a high-performance system based on Reduced Instruction Set Computer (RISC) technology, an innovation pioneered by IBM to execute most instructions in a single cycle. Designed with the UNIX™ environment in mind, the RT can run hundreds of existing programs and

IBM RT™ Specifications	
Users	1-32
System Memory	2MB-16MB
Operating System	AIX (native mode)
Languages	C, Advanced C, VS Pascal, Pascal, Basic, VS Fortran, Fortran 77, RM Cobol, Common LISP, Assembler
Data Base	Oracle,™ Ingres
Microprocessor	RISC processor, 170 or 100 nanoseconds, 20MHz Motorola 68881 Floating Point unit

RT and AIX are trademarks of the IBM Corporation.
UNIX is a trademark of AT&T Bell Laboratories.
Ethernet is a registered trademark of Xerox Inc.
NFS (Network File System) is a trademark of SUN Microsystems.
Oracle is a trademark of the Oracle Corporation.



take full advantage of future AIX™ and UNIX innovations.

To meet your complex communications requirements, the RT supports TCP/IP, ASCII, SNA, Ethernet®, Token-Ring and NFS™ networking configurations for homogeneous/heterogeneous distributed networks for up to 32 users per RT. And you can easily customize your RT system to your particular needs using languages and programming tools for commercial, scientific and expert system applications.

Add to this winning formula the RT's advanced memory management, data base management systems, floating point capabilities and IBM's unparalleled service and support. And you've got quite a computer, indeed.

To arrange for a call from an IBM marketing representative or an IBM industry remarketer, or for literature, call 1-800-IBM-2468, Ext. 41.



The Bigger Picture

SIEMENS

Into a new TV future – with high technology from Siemens

Every year Siemens supplies millions of integrated circuits to the producers of entertainment electronics. Day by day more than 100 million TV viewers make use of this modern IC technology – in cable and satellite TV, for video and teletext.

Siemens has set standards in advancing technology for entertainment electronics:

- In 1969 Siemens came along with the first IC for television sets, an FM IF amplifier, a device that became a standard worldwide, and still is. More than 100 million of them have already been produced.
- Siemens was also first in devising a modular concept for stereo/dual-sound TV, and put it into serial production.
- ICs from Siemens are also standard worldwide in the power supplies of television sets and video recorders.

Those are just a few of the pioneering achievements from Siemens, and part of a continuing process. Working together with users, for instance, and applying the latest technologies, Siemens is currently devising a new generation of ICs for the TV set of the future, with all the new media possibilities like broadcast and interactive videotext, VPS... Even now Siemens is putting digital video signal processing onto the market in a flexible device package – for digital television. Meaning that in future even different standards like PAL, SECAM, NTSC and D2 MAC (TV Sat) can easily be handled digitally in one and the same TV set.

Siemens not only has the engineering and expertise for mastering complex problems, it also has the innovative power. Find out more about our extensive range of modern ICs for entertainment electronics. Write Siemens AG, Infoservice 12/Z038, Postfach 2348, D-8510 Fürth quoting "ICs for entertainment electronics".

Integrated circuits
and systems
for entertainment electronics

CIRCLE NO 134

Sound and IF

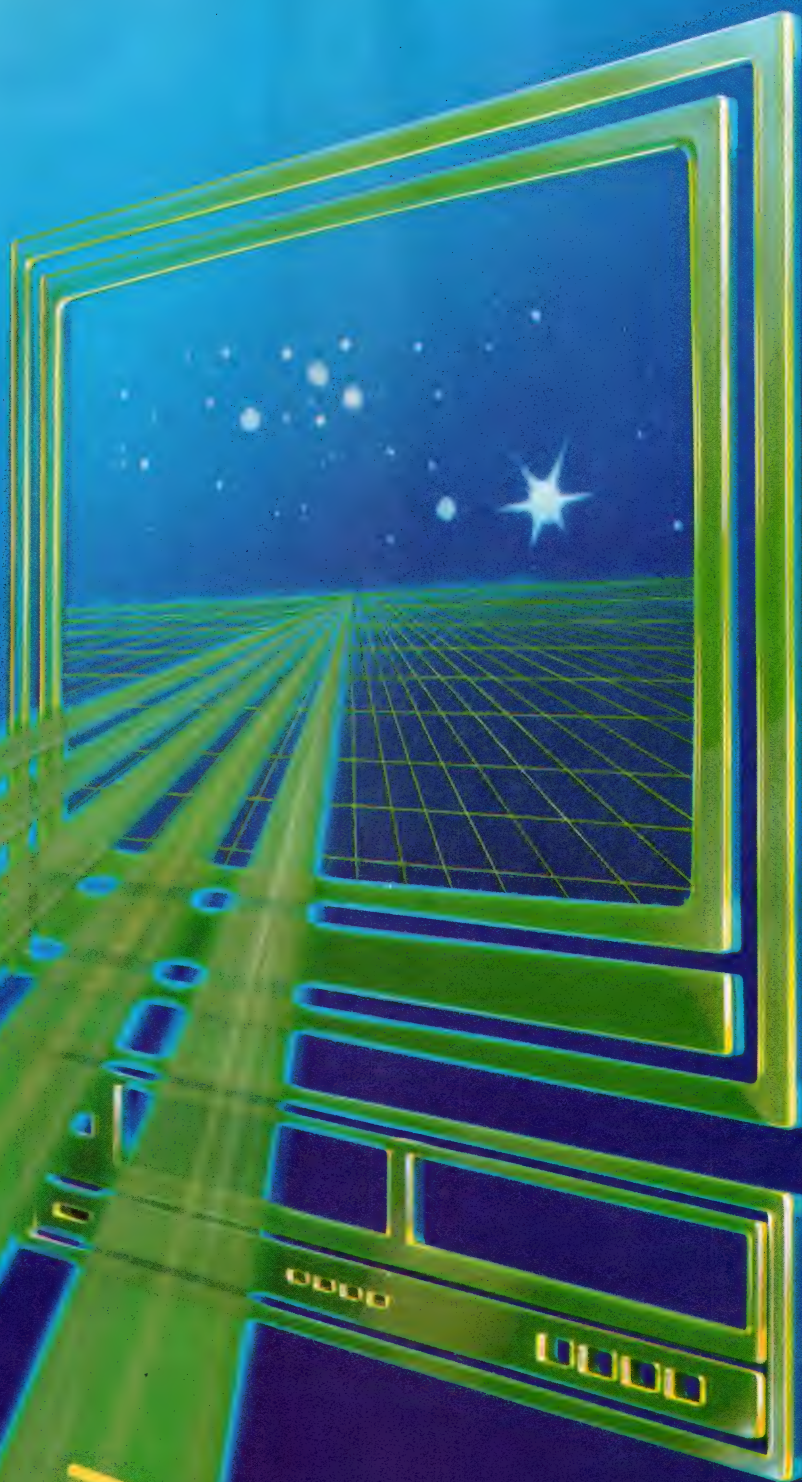
Tuner ICs

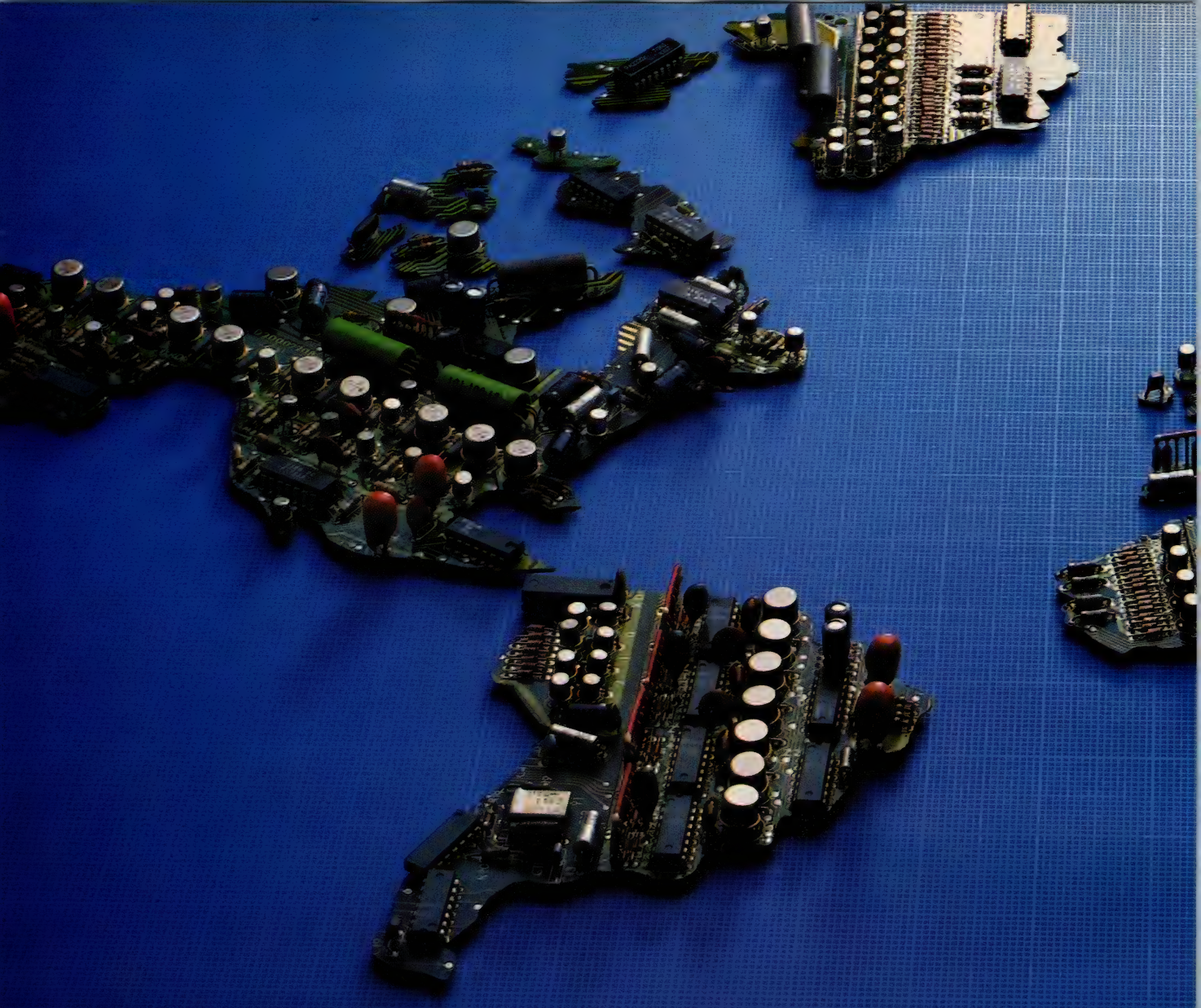
Switched Mode

Supply ICs

Features

Digital TV





CIBA-GEIGY's world of electronic chemicals.

In seventeen countries around the world, the unparalleled research and development capabilities of CIBA-GEIGY Group Companies are advancing the technology of electronic chemicals and processes.

Layers of electronic magic held fast by Araldite® resins.

Today's printed circuits must combine extremes of circuit density with flexibility, strength and precision. The

secret is Araldite laminating resins, products of CIBA-GEIGY research. These resins blend the best mechanical and dielectric properties with resistance to hot-air levelling and a steadfast refusal to delaminate even when exposed to solder baths. Result: lighter, stronger and more reliable circuits.

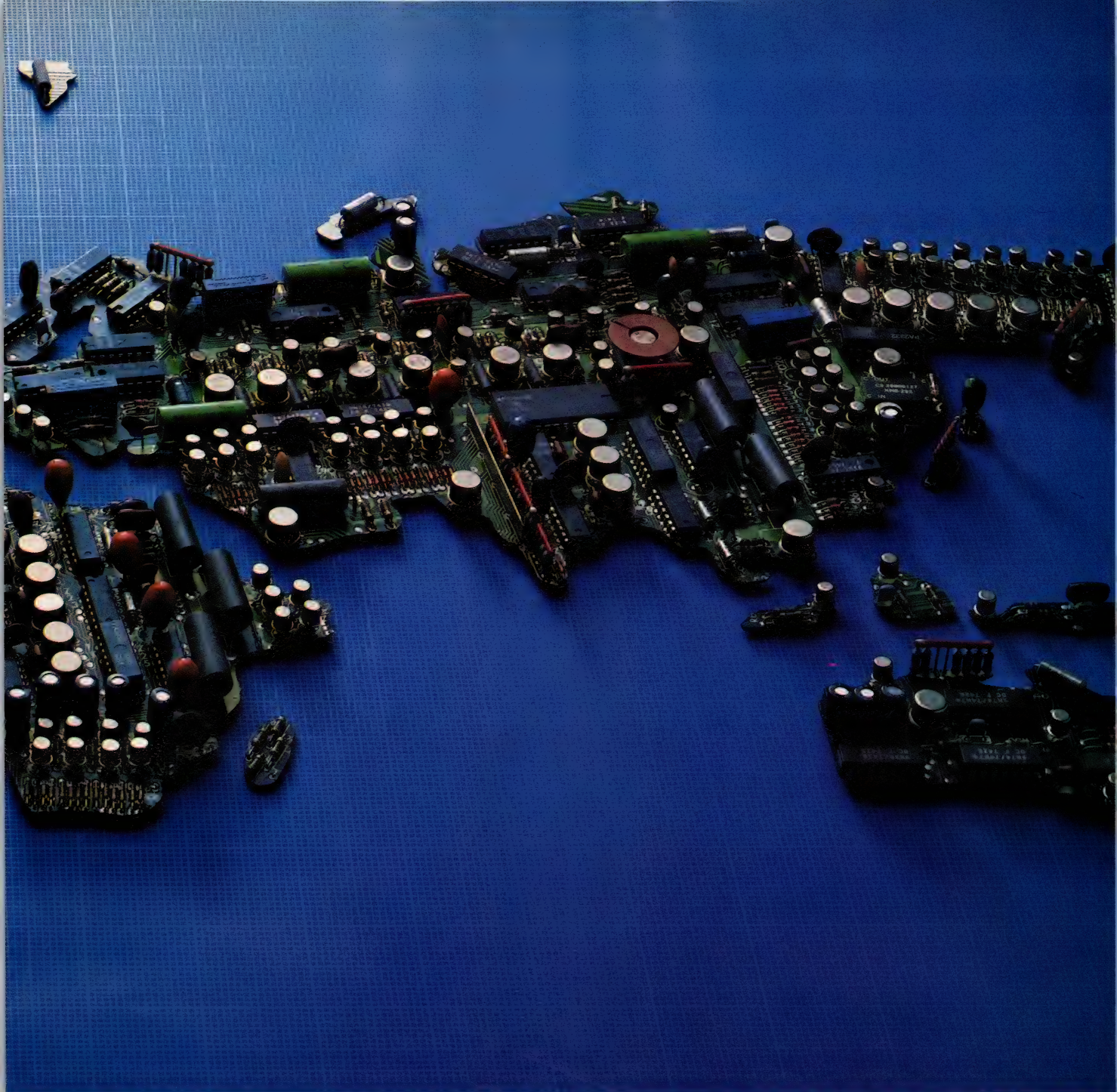
Tomorrow's photopolymer solder mask today: The Probimer® series.

A comprehensive system capable of masking printed wiring boards of exceptionally high density with little possibility of solder bridging or distortion, the Probimer technology provides an extraordinary level of fidelity to the photographic contours of the original.

Further Probimer advantages: a tough protective coating imbued with flame retardance and a high level of resistance to chemical and environmental attack.

High-purity protection: The superb Aratronic® encapsulation systems.

Heat, cold, extremes of pressure and environmental exposure: These are just a few of the adverse conditions an electronic component may have to endure. And endure it will, when protected with high-purity Aratronic encapsulation systems. These systems offer negligible shrinkage during cure, excellent adhesion to metals and other materials, and stalwart resistance to chemical attack.



Improved cost-effectiveness and reliability for semiconductors and hybrid circuits: Probimide® microelectronic systems.

Probimide polyimides are an advanced high-purity mask and photopolymer coating developed especially for the stringent requirements of today's semiconductors and hybrid circuits. They provide heat resistance up to 450°C and their photoimageability has resolution capability into the micron range, hundreds of times better than the best photographic film.

Pulling it all together: Furane Products specialty polymers.

For packaging and assembling

electronic components, CIBA-GEIGY's Furane Products Company formulates specialty polymeric materials to meet the ever-increasing demands of industry.

Uralane® conformal coatings can be used in most hostile conditions of heat and humidity. Epibond® die attach adhesives meet demanding military specifications for thermally conductive/ electrically insulating adhesives.

A global capability: Wherever there is technology, there is CIBA-GEIGY.

CIBA-GEIGY Group Companies literally circle the globe with highly sophisticated technological and service capabilities. For more information, please contact: In the U.S.A. CIBA-GEIGY

Corporation, Electronic Chemicals Group, Three Skyline Drive, Hawthorne, New York, 10532. Telephone: (800) 431-1900, (914) 347-4700 in New York. In other countries, please contact the local CIBA-GEIGY Group Company or CIBA-GEIGY Ltd., Electronic Chemicals (KA 5.6), 4002 Basel, Switzerland, Telephone: 061/362850.

CIBA-GEIGY

The sun never sets on
CIBA-GEIGY'S
world of electronic chemicals

High-Performance LCD Modules

DAYSTAR NOVATM

* IEE DAYSTAR NOVA *
WIDEST AVAILABLE
TEMPERATURE RANGE
FROM -30 TO +85°C

* IEE DAYSTAR NOVA *
WIDEST AVAILABLE
TEMPERATURE RANGE
FROM -30 TO +85°C

* IEE DAYSTAR NOVA *

DAYSTAR NOVA HIGH PERFORMANCE LCDs
HIGH CONTRAST 5x7 DOT MATRIX CHARACTERS
EASY TO READ IN SUNLIGHT OR DARKNESS
WITH OPTIONAL E.L. BACKLIGHTING

* DAYSTAR NOVA LCD *
LARGE .5" CHARACTERS

DAYSTAR NOVA LCD MODULES OFFER A CHOICE
OF TWO VIEWING ANGLES: -20° OR +20°

IEE DAYSTAR NOVA LIQUID CRYSTAL DISPLAYS



Industrial Products Division
INDUSTRIAL ELECTRONICS ENGINEERS, INC.
7740 Lemona Avenue, Van Nuys, CA 91409-9234
Tel. (818) 787-0311, Ext. 418

Ask about our Evaluation Kit Offer!

CIRCLE NO 137

Retargetable tools ease microprogramming of SIMD processors

You can improve your single-instruction, multiple-data processors dramatically by using effective organization and management techniques. Retargetable tool sets can help you program these massively concurrent SIMD processors conveniently, reliably, and inexpensively.

Robert A Mueller and Daniel R Benua,
Quantitative Technology Corp

One way to create programmable parallel computer systems is to use wide-instruction-word, single-instruction, multiple-data (SIMD) processors. But machines with concurrently functioning units require programs that are far more complex than similar programs for conventional sequential computers or microprocessors. Programming at the microcode level is therefore tedious and exacting—it calls for a special combination of talent and patience that not many programmers possess. Until recently, the only alternative was to lower performance and thus create a more manageable machine for the microprogrammers. However, using SIMD architectures is now a feasible option because automated tools for implementing microcode within

those architectures are starting to appear, and these tools offer new methods for resolving the programming difficulties.

SIMD architectures have become the basis of most contemporary high-performance graphics and digital-signal-processing (DSP) systems. Such systems generally consist of custom, application-oriented processors built from a mixture of high-speed arithmetic, floating-point, DSP, and application-specific integrated circuits (ASIC), that provide excellent cost/performance value. In addition, it's possible to design wide-instruction-word SIMD processors in such a way that you can program them in a high-level language (HLL). This advantage becomes significant when optimizing compilers are available to translate HLL programs into *microcode* (for definitions of all the italicized words in this article, see **box**, "Microcode terms decoded").

The wide instruction words used in SIMD processors (from 64 to more than 1000 bits) can be extremely difficult to program efficiently. The reason is that every instruction word contains numerous fields, and every field controls different hardware elements. You must therefore program each field for each clock cycle of an instruction. Furthermore, because you can *pipeline* many hardware elements, one operation can take several instruction cycles to complete, and an operation's later stages may take place concurrently with the early stages of the next operation.

If a SIMD architecture must support large applica-

Programming at the microcode level requires a special combination of talent and patience that few programmers possess.

tion *microprograms*, the hardware designer can take advantage of some powerful chip families to quickly design systems that, because of extensive concurrency and pipelining, can perform exceptionally well. On the other hand, developing software for such an architecture is difficult. In the first place, microprograms are generally not written until after the design is set in silicon, so any early prediction of such a system's performance when running microprograms is just about impossible. Thus the hardware designer must speculate about the software needs, and major design flaws can go unnoticed until it's too late to rectify them. When you add to this the fact that each application program may require 100,000 or more *microinstructions* operating on such an architecture, the intractability of programming those applications is clear.

In fact, most vendors estimate that if traditional microcode development tools are used, writing and debugging microcode on wide-word, SIMD architectures costs between \$1 and \$2 per bit. Thus, an application requiring 100,000 microinstructions, where each microinstruction is 100 bits wide, might cost between \$10 million and \$20 million to develop.

In order to eliminate current design problems without sacrificing a high level of performance, a microcode development system should feature four basic characteristics:

- You should be able to easily *retarget* the tools for different architectures, including hypothetical machines. An automated system is inadequate if it works for only one design, or even for a limited number of designs. Designers must be able to

Microcode terms decoded

Code compaction—The process of scheduling a sequential list of straight-line micro-operations to execute concurrently on a parallel processing machine, without violating resource limitations or data dependencies.

Configure—To adapt retargetable program-development tools for a specific hardware architecture. Configuring involves writing a configuration file and processing it for use by the development tools.

Configuration file—A text file containing descriptions of the hardware and the properties of a target machine. This information is needed to adapt the retargetable program-development tools to a specific hardware architecture. The file is used as input to a configuration program that performs the adaptation of individual tools.

Data dependence—A relationship that involves the reliance of one operation on the data of another. An operation X is data-

dependent on operation Y, if Y writes data that X reads.

Horizontal machine—A machine architecture in which independently programmable operations can occur simultaneously as well as sequentially. Such a machine may have multiple concurrent functional units but only a single program-sequence control unit.

Local compaction—Code compaction.

Microcode—A general term for the machine instructions that directly control the hardware resources of a machine.

Microinstruction (MI)—A source-level assembly-language instruction made up of zero or more micro-operations and corresponding to an object record.

Micro-operation—A primitive operation that controls specific hardware resources of the machine.

Microprogram—A sequence of microinstructions that together perform a specific function. A

microprogram can exist at three levels: source, object, and loadable.

Pipelining—The process of combining operations in such a manner that successive operations are initiated before the first operation is completed. The number of cycle transitions that occur before completion of the first operation defines the depth of the pipeline.

Retarget—To change, or reconfigure, a program for an architecture that is different from the one you last worked on.

Software pipelining—A program-optimization technique that pipelines the operations of a program loop.

Target machine—The computer system for which microcode is written.

Trace scheduling—An optimization that speeds up the program paths that execute most frequently in a microprogram.

LISTING 1—C PROGRAM FOR A 4x4 MATRIX PRODUCT

```
int a[4][4];
int b[4][4];
int c[4][4];

main()
{ int i,j,k;

  for(i=0 ; i<4 ; i++)
    for(j=0 ; j<4 ; j++)
    {
      c[i][j] = 0;
      for(k=0 ; k<4 ; k++)
        c[i][j] = a[i][k]*b[k][j]+c[i][j];
    }
}
```

explore new possibilities in order to make use of the most advanced technology. Limitations on system configuration hamper both their creativity and their ability to exploit new technology.

- You should be able to write microcode in a high-level language. An automated system must allow the reuse of existing microcode on new architectures. Reusability requires that microcode be written in a high-level, machine-independent language. A language that is appropriate, popular, and standardized has added value for the programmer.
- It should automatically (or at least semiautomatically) optimize microcode to effectively exploit concurrency and pipelines. New hardware technology is cost effective only if programming techniques are capable of yielding the full performance potential of the resulting system. Hand coding requires programmers who are both experienced with optimization methods and have an expert knowledge of the target hardware. Even with such expert programmers, hand coding for wide-word SIMD processors is, at best, very time-consuming and expensive. For complex, highly concurrent machines, hand coding can be too difficult for even experts to manage effectively and reliably.
- It should readily provide architectural performance profiles that reveal bottlenecks and other design flaws. The designer must be able to assess the effectiveness of an architecture, when running a representative benchmark suite of microprograms, by means of execution profiles. To obtain such execution profiles, the development system must include a retargetable simulator.

Taking these characteristics into account, let's see what tools you need to automate both the SIMD processor design and the microcode development for such processors. Keep in mind that all of the tools should be retargetable—that is, you are able to adapt them to any architecture, provided that a description of that architecture and its programming rules is available in a *configuration file*.

First of all you need an assembler and a linker that you can easily adapt to various symbolic assembly languages, including those for expressing horizontal instructions and pipelined operations.

Next, to reduce programming time and cost, and to facilitate the reuse of existing code, you need a compiler for a high-level systems-programming language like C. The HLL compiler should generate code for the selected assembly language. To exploit the low-level, fine-grain parallelism, it's critical that you have an optimizer that trace-schedules programs, pipelined loops, and scheduled concurrent operations, both for handwritten and compiled code. HLL compilers can have some built-in optimizing functions, but it's very likely you'll need a separate optimizer tool for fine-tuning the source code generated by the compiler.

A symbolic debugger is also essential, preferably one that shows you the HLL source code as well as the machine code that's currently executing. Debugging a complex single-thread program is often difficult without a source-level debugger—the mind boggles at the thought of debugging parallel or pipelined operations without this aid.

And finally, you need a simulator, not only to test and profile new programs, but to evaluate the performance of the proposed system even before it's committed to silicon.

Powerful chip families allow you to quickly specify systems that can use concurrency and pipelining extensively to achieve high performance.

$$\begin{pmatrix} C_{11} & C_{12} & C_{13} & C_{14} \\ C_{21} & C_{22} & C_{23} & C_{24} \\ C_{31} & C_{32} & C_{33} & C_{34} \\ C_{41} & C_{42} & C_{43} & C_{44} \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} & a_{13} & a_{14} \\ a_{21} & a_{22} & a_{23} & a_{24} \\ a_{31} & a_{32} & a_{33} & a_{34} \\ a_{41} & a_{42} & a_{43} & a_{44} \end{pmatrix} \cdot \begin{pmatrix} b_{11} & b_{12} & b_{13} & b_{14} \\ b_{21} & b_{22} & b_{23} & b_{24} \\ b_{31} & b_{32} & b_{33} & b_{34} \\ b_{41} & b_{42} & b_{43} & b_{44} \end{pmatrix}$$

Fig 1—This general form of a 4×4 matrix multiplication uses the standard approach of cross-product computations. It requires 64 additions and 64 multiplications.

A tool set that includes all these programs offers a new approach to design. For example, you can develop large benchmarks of machine-independent C programs in advance of, or concurrently with, the processor

design. First, you *configure* the entire tool set for that architecture by building a configuration file from which each tool can extract details of the machine-specific properties of the target architecture. Once you have configured the tool set for your design, you can begin the compilation, optimization, and assembly of system and application programs.

To obtain performance profiles and analysis, you run the compiled programs under the simulator. When design flaws or opportunities for improvement crop up, you can make changes and update the configuration file accordingly; the feedback loop then repeats. In situations where you need to compare and contrast alterna-

An integrated set of tools for microcode

The Software Foundry from Quantitative Technology Corporation (QTC) is an integrated family of software development tools that can easily be re-targeted by designers of custom high-speed processors for different architectures. The family consists of six tools.

C compiler

The retargetable SF/C Compiler compiles C source code directly into optimized microcode. It performs the first of two stages of optimization: coarse-grain transformations of the programmer's code. This first optimizing stage includes eliminating common subexpressions, constant propagation, copy propagation, constant folding, strength reduction, and peephole optimizations. It also encompasses code motion, dead code removal, redundant code elimination, and register assignment.

Because it's retargetable, the package can compile machine-independent programs for a large number of architectures. A de-

sign team can thus write application code concurrently with, or even in advance of, the design of the architecture to which the microcode is targeted.

Optimizer

The S/F Optimizer performs the second stage of optimization. This tool reorganizes syntactically correct microcode so that it can do low-level, fine-grain code improvements. It can use any parallelism and pipelining available for a given processor architecture. It improves code efficiency by using compaction, loop folds, and *trace scheduling* optimizations that relate specifically to the target architecture. The SF/Optimizer produces code that typically runs many times faster than the input code.

To improve the microcode's efficiency, the SF/Optimizer operates in both an interactive and an automatic mode. In the interactive mode, the SF/Optimizer provides immediate feedback from the editor-assembler to the operator. This feedback assists the programmer by providing

data-dependency and resource-usage information that is crucial to achieving an optimally written microcode program.

In automatic mode, the SF/Optimizer manipulates the input microcode, using several optimization techniques. One such technique is *code compaction*. Code compaction, operating on straight-line *micro-operation* sequences, produces code that runs more efficiently and takes less space in program memory.

The optimizer also optimizes via *software pipelining*. This operation provides significant speed improvements for sections of code that contain loops. Consider, for example, a simple loop that adds corresponding elements of two large arrays of numbers and stores the results in a third array. For processors that have parallel and pipelined computing resources, the Optimizer increases execution speed in loops by folding the microcode into a number of stages, each of which performs a portion of the total calculation. For example, it might fold a 12-operation

tive designs, you can write several different configuration files and then evaluate the various processors under the benchmark programs.

When your design is completed, you need little extra time for completing the entire microprogrammed system, because you've probably already developed and debugged many of the microprograms with the tool set. If you need to adjust the programs further, you can use the assembler and optimizer to streamline potential program trouble spots for very high performance. This streamlining enhances the quality of your SIMD designs and can dramatically reduce design costs and system development time. The result is better systems

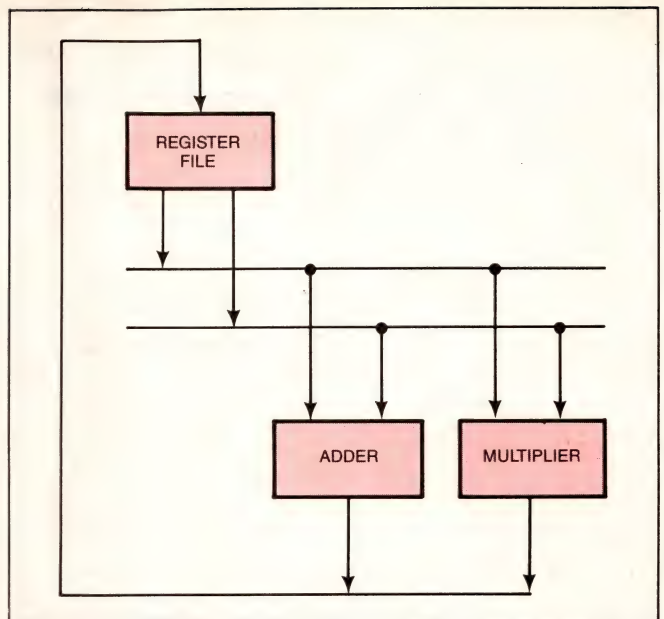


Fig 2—This simple design contains separate adder and multiplier units. The additions and multiplications must be executed sequentially.

straight-line loop into 4 stages, each of which takes only 3 cycles. Thus, when the processor executes the folded loop, only 3 cycles are needed to produce each result. This reduction in cycles improves the performance by a factor of four, compared to that of sequential code.

A third optimization involves *trace scheduling*. This process moves operations around control branches on the basis of the statistics on the relative execution frequencies of the various program paths. The goal is to speed up those program paths that are expected to run most frequently.

Assembler

The QTC SF/Assembler forms the foundation for all the tools in the family. It's a microcode meta-assembler that lets the developer customize a microcode programming language for a specific *target machine*. This tool supports the features found in many modern standard assemblers, like macros, include files, multiple code and data memories, conditional assembly, and

modular, relocatable code.

The SF/Assembler is designed to give the users the flexibility to design syntax that has the attributes and power of a high-level language, while they retain explicit control of the machine resources. The package also accommodates those users who feel more comfortable defining their language syntax at the instruction-field level.

Linker

The SF/Linker allows you to combine object files from a number of separately assembled subprograms into a single program module. The linker then formats modules into one of several selectable standard output formats for loading either into the actual target hardware or into a software simulator of the hardware.

Simulator

The retargetable SF/Simulator runs on the development host and can simulate the execution of an assembly- or microcode-language program as it would run on the target machine. It

uses a description of the target machine's hardware that is based on the same configuration file used by the SF/Assembler and SF/Optimizer. Because the SF/Simulator allows a large number of programmers to develop and check out applications code, regardless of the availability of the hardware, its use can substantially reduce the overall time for completion of a project.

Symbolic Debugger

The SF/Debugger permits the programmer to refer by name to the program variables whose contents he wishes to examine and modify. The SF/Debugger uses the SF/Simulator to execute the compiled code exactly as if it were running on the actual hardware. The SF/Debugger also provides a convenient interface to other programs, so that the user can write his own routines to communicate with actual hardware for hardware system debugging.

Assessing application microprograms is difficult because they're not usually written until after the design is set in silicon.

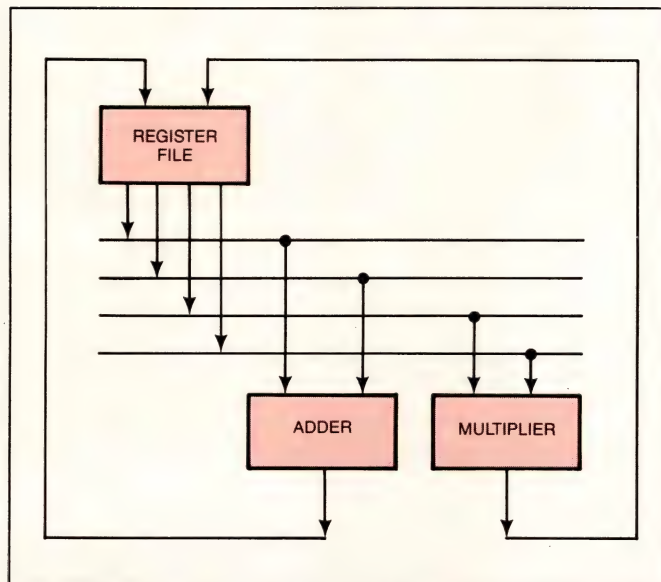


Fig 3—This design contains separate adder and multiplier units. The additions and multiplications can be executed concurrently.

that run faster and cost less.

To illustrate some of the benefits of such a tool set, consider a scenario in which you need to design a computer for fast execution of 4×4 matrix multiplications. This problem is very common in systems designed for high-performance image analysis and rendering. You'll typically work through several versions of the computer from a simple, conventional, sequential bit-slice design to an SIMD architecture.

Along the way, you'll need to know how effective the design is in two respects: First, how programmable is it? That is, will it be possible to write microcode for the machine so as to exploit the features designed to provide greater performance potential? Second, is the performance the machine was designed to provide achievable through microcoding?

Computing a 4×4 matrix illustrates concretely how you actually might use these tools. Matrix multiplica-

LISTING 2—INNERMOST LOOP OF SEQUENTIAL MICROCODE

```
Cycle 1. t = a[i][k] * b[k][j];
2.          ; No-op
3. c[i][j] = t + c[i][j];
```

tion is a very common computation, so the following example touches only on the arithmetic operations and skips over the other issues, such as memory traffic, that a designer would normally have to take into account in the designing process. The example also assumes the presence in the design of all necessary loop operations, variable initialization, addressing, and memory accesses.

Work through a practical example

The problem is to efficiently compute $c=a:b$ (Fig 1). You could just design a bit-slice architecture (Fig 2) that allows a single scalar addition or a single scalar multiplication in any instruction cycle. In this case, a scalar addition would execute in one cycle, and a scalar multiplication in two cycles.

A typical C program that computes a 4×4 product is shown in Listing 1. Simply counting the additions and multiplications reveals that the innermost loop of this program contains one addition and one multiplication, each of which is executed 4^3 , or 64, times. A simple microcoded solution corresponding to the C loop contains the operations shown in Listing 2. If you count the instruction cycles needed to perform these operations, and then count the number of passes through the loop, you'll find that the complete matrix multiplication requires 3×4^3 , or 192, instruction cycles.

Next, you might want to consider an architecture that can perform the scalar additions and multiplications concurrently (Fig 3). To obtain the concurrent operation, you have to change the configuration file (the

LISTING 3—PROGRAM THAT FOLDS THE INNERMOST LOOP

PREAMBLE TO THE INNERMOST LOOP:

```
Cycle 1. t[1] = a[i][1] * b[1][j] ;
2.          ; No-op
```

INNERMOST LOOP BODY (executed for k=2...4):

```
Cycle 1. c[i][j] = t[k-1] + c[i][j] # t[k] = a[i][k] * b[k][j];
2.          ; No-op
```

POSTSCRIPT TO THE INNERMOST LOOP:

```
Cycle 1. c[i][j] = t[4] + c[i][j] ;
```


MSK 738

OP-AMP

fast! ...

3500 v/ μ s slew

accurate!...

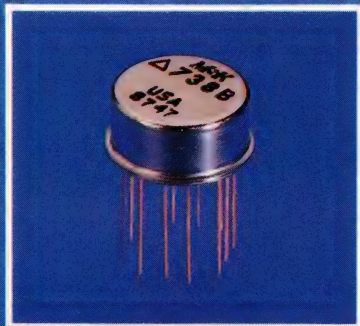
25 μ V offset

quiet!...

.15 μ Vp-p noise

They don't get any better than this!

- ± 120 mA OUTPUT
- ± 12 VOLTS INTO 100Ω
- 20 MHz FULL POWER BANDWIDTH
- 200 MHz BANDWIDTH
- 30 nS SETTling TO .1%
- 110 dB VOLTAGE GAIN
- .5 μ V/ $^{\circ}$ C OFFSET DRIFT
- NO THERMAL TAIL!



MSK Soars Again!

M.S. Kennedy Corporation

8170 Thompson Road, Clay, New York 13041 Phone: (315) 699-9201

An automated microcode development system must be retargetable to any hardware architecture if it is to be useful.

LISTING 4—PROGRAM THAT FOLDS BOTH INNERMOST AND MIDDLE LOOPS

PREAMBLE TO THE MIDDLE LOOP:

Cycle 1. $t[1] = a[i,1] * b[1,1]$;

MIDDLE LOOP BODY (executed for $j=1...3$):

INNERMOST LOOP BODY (executed for $k=2...4$):

Cycle 1. ; No-op

2. $t[k] = a[i,k] * b[k,j] \# c[i,j] = t[k-1] + c[i,j];$

POSTSCRIPT TO THE INNERMOST LOOP:

Cycle 1. ; No-op

2. $t[1] = a[i,1] * b[1,j+1] \# c[i,j] = t[4] + c[i,j];$

POSTSCRIPT TO THE MIDDLE LOOP:

Cycle 1. ; No-op

2. $t[2] = a[i,2] * b[2,4] \# c[i,4] = t[1] + c[i,4];$

3. ; No-op

4. $t[3] = a[i,3] * b[3,4] \# c[i,4] = t[2] + c[i,4];$

5. ; No-op

6. $t[4] = a[i,4] * b[4,4] \# c[i,4] = t[3] + c[i,4];$

7. ; No-op

8. $c[i,4] = t[4] + c[i,4]$;

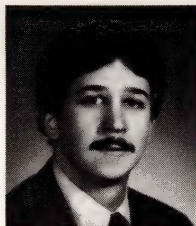
C program, however, can remain the same). If you recompile the program, and the compiler performs only a *local compaction* of instructions (that is, the instructions are not moved around control block boundaries), you would obtain the same microcode.

Because the next scalar multiplication can begin as soon as the addition at the bottom of the loop is done, you can improve the program's efficiency by overlapping the additions with the multiplications. Specifically you can optimize the program by unrolling and folding the innermost loop body to achieve the overlapping operations and then rerolling the innermost part. The result is shown in Listing 3. (The # delimiter separates operations that are executed in parallel.) The resulting code performs these arithmetic operations in $(2+(2 \times 3+1) \times 4)^2$, or 144, instruction cycles (the parentheses in the arithmetic expression reflect the looping structure of the program).

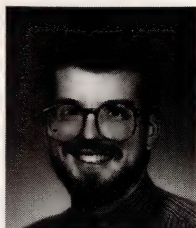
A very powerful optimizer can automatically determine the benefit of performing this optimization, and then take things one step further. The optimizer would unroll, fold, and reroll the middle loop as well, and so reduce the total time still further. Most programmers would probably overlook this possibility, and those who recognized the possible benefits might shy away from it because of the complexity of the required code reorganization. The result of the transformation is shown in Listing 4. The highly optimized loop now requires only $(1+(2+(2 \times 3) \times 3 \times 8) \times 4)$, or 132, instruction cycles. **EDN**

Authors' biographies

Robert A Mueller is QTC's director of research. He was previously president and founder of Horizon Research Labs, which was acquired by QTC in July 1987. Bob is currently on sabbatical leave from Colorado State, where he is associate professor and director of the firmware-engineering and micro-architecture design laboratory. He is a recognized expert on microcode optimization, and has published more than 75 papers. Bob holds a BS in computer science and an MS in mechanical engineering from Colorado State University and a PhD in computer science from University of Colorado. He's a member of the ACM and the IEEE. In his spare time, he enjoys bicycling.



Daniel R Benua develops new products for QTC as a senior software engineer. Before joining QTC early in 1984, Dan worked at Spacelabs. He holds an MSEE from Stanford University and a BSEE from Brown University, and is a member of the ACM.



Article Interest Quotient (Circle One)
High 485 Medium 486 Low 487

One if by land...



Official U.S. Army photograph

Two if by sea...



Official U.S. Navy photograph

Three if by air...



All from GE.

The combined forces of GE, Intersil and RCA—now #1 in High-Rel CMOS, and a leader in linear and power—give you a powerful ally for all your military needs.

There's more to choosing a military semiconductor supplier than finding the right parts. You need a technological partner who is as committed to the business as you are. A partner with the experience, expertise and production capabilities to serve this demanding market.

more than 1.5 million ASICs last year. We offer rad-hard and non-rad-hard, Class S and Class B ASICs.

With decades of military experience, fully-equipped design centers worldwide, and software that is exceptionally easy-to-use, we can help you translate your

ideas into silicon *fast*. With first-time success of virtually 100%.

You can use our new silicon compiler technology to create designs that are heavily bus-structured, with ROMs, RAMs, PLAs and ALUs right in them.

Or choose from dozens of fully-characterized cells to design ASICs to more than 10,000

gates. With die sizes up to 150,000 mil². Our range of ASIC technologies is impressive, including bulk silicon from 1.5 micron to 7 micron; 1.5 micron silicon-on-sapphire; single- and double-level metal.

All supported by a team of experienced, dedicated High-Rel designers and engineers.

LOGIC

RCA invented CMOS. And

RCA Class S and Class B CMOS logic has long been the first choice for military and aerospace systems. For both rad-hard and non-rad-hard applications.

The CD 4000 series, introduced over 18 years ago, includes hundreds of devices proven in dozens of successful tactical programs.

We increased speed tenfold with the 54HC/HCT family, which now includes more than 250 types and is fully compliant to 883B Rev.C.

We tripled the speed again with our 54 AC/ACT series, matching bipolar ALS in speed. These devices can be used to replace LS and ALS circuits at only a small fraction of the power consumption.

And our newest line, now being introduced, is 54 HCS/HCTS.

The "S" indicates that this family is made on sapphire substrate.

HCS/HCTS is just like HC/HCT except for two important advantages: the speed of AC/ACT; and radiation hardness (over 200K Rads, screened to Class S).

Representative GE Solid State Credentials

Satellite, Aerospace 10⁵ and 10⁶ RAD Levels

Atmosphere Explorer	Sat Com Nimbus	Imp Satellites IUE	Galileo Voyager I & II	SICBM MILSTAR
7 OP	Helios	VELA	Lightweight Receiver	GPS COBE
HEAD	DMSP	Vega I & II	IUS	SDI
Space Shuttle	Oscar-6	Geosat	GOES	DSCS
ITOS	Pioneer-F	AMPT	INSAT	LANDSAT
B-Sat	ATS	TIROS		

Tactical Military Programs

Tow Cobra	ARC-164	Multi-Role	M-56	GEMNS
Tenley	PRC-85	Combat Air	XM-70	GATOR
S-3A Aircraft	Stinger	AN-TPN-19	ADAM	KG84A
Lans Program	Captor	AN-ASQ-119	FMU-112B	KG84C
TD-1065 Communication	Manpack	Arctic Beacon	FMU-117B	STU II
Vinson	Skiru	AWACS	Ptarmigan	STU III
Airs	AN/ALE 139	MK 46	TICM	KGV 10
ARC-150	DMD/PLARS	NYVO	Sparrow	Copperhead
	Parkhill	B155	SINCGARS	Hellfire

That's why you should take a close look at what the merger of three great brands—GE, RCA and Intersil—means to you.

ASICs

GE Solid State is a leading supplier of High-Rel ASICs. Many ASIC companies concentrate only on front-end design. We're strong in design, but equally strong in volume production. In fact, we shipped



INTERSIL

Intersil's commitment to the military market goes back to 1974.

Today, Intersil can offer you more than 300 JAN QPL and 883B, Rev. C devices, including analog switches, multiplexers, JFETs, voltage converters, power-supply-management ICs, UARTs, EPROMs, timers and data acquisition products.

Plus one of the world's broadest lines of analog-to-digital and digital-to-analog converters and extremely sophisticated DSP devices.

There are currently more than 10,000 active Intersil customer source-control drawings on file.

RAD-HARD CMOS/SOS

If you're designing aerospace or strategic military systems, CMOS/SOS should be your choice. That's because the sapphire substrate gives you totally isolated n and p devices, for high speed and outstanding radiation hardness.

The advantages of CMOS/SOS are available in rad-hard ASICs, RAMs and HCS/HCTS logic. CMOS/SOS devices are the key to the success of major

military programs like Milstar and

Minuteman small ICBM. CMOS/SOS is virtually latch-up free under transient radiation.

It has extremely high tolerance to single event upset (SEU) caused by radiation. For example, SRAMs typically have SEU of 2×10^9 errors/bit/day. SOS offers a very high total dose tolerance: all the way from 100K Rads to "MEGARAD" dosage.

We know, because we invented SOS.

1750A PROCESSOR

When Rockwell needed super-reliable, proven, rad-hard components for their 1750A processor (used in the new small ICBMs), they turned to us.

We responded with the ASIC that did the job: the MIL-STD 1750A embedded processor.

The processor has speed >700 KOPS (dais mix). The CPU uses six LSI logic chips implemented with our standard cells.

RAMs

We're delivering rad-hard 16K SRAMs, screened to Class S, in high volume.

These 16Kx1 RAMs are latch-up free; with SEU of 2×10^{10} errors/bit/day; transient upset rate $>10^{10}$ Rads/second; and total dose tolerance $>100K$ Rads (Si). Access time is 80 ns typical at 25°C (post-Rad access time is 150 ns).

Our 4Kx1 and 1Kx4 rad-hard SRAMs are being qualified to

M38510 Class S.

Also, we offer 64K (8Kx8) and 256K (32Kx8) non-rad-hard high-rel SRAMs.

POWER

We're among the leaders in high-rel power, with more than 200 QPL Bipolar and MOSFET devices.

We invented the logic-level high-rel MOSFET, which has a 5-volt gate drive.

Another invention of ours, the IGT, achieves a 10:1 improvement in on-state resistance over conventional power MOSFETs when operating in the 400-to-500 volt range.

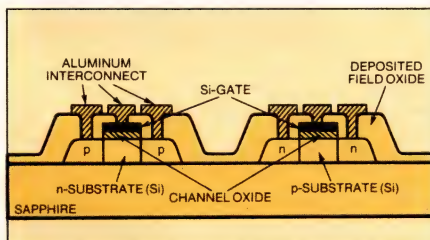
And we now offer Rugged MOSFETs, which can withstand high levels of avalanche energy.

GE Solid State has been awarded more engineering development contracts for rad-hard MOS than any other semiconductor supplier.

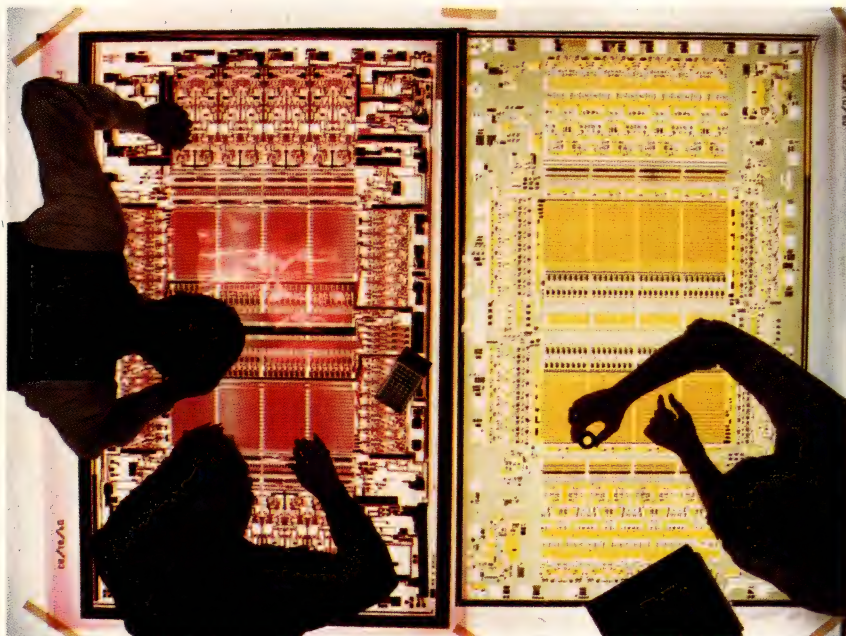
GE Solid State has the only DESC approved MOVs in the industry. And we can screen any of our 248 GE-MOV® Varistors to your high-rel requirement.

MANUFACTURING

Except for GE-MOVs, which are made in Dundalk, Ireland, all GE Solid State wafers are fab-



CMOS/SOS structure uses sapphire substrate to insulate the n- and p-transistors from each other. This structure is highly resistant to transient radiation, total-dose radiation, and single-event upsets.



ricated in the U.S.A.

Our main high-rel plant is in Findlay, Ohio. One of the world's most efficient front ends, Findlay boasts a state-of-the-art high volume wafer fab plus complete military/aerospace assembly and test facilities, JAN certified to Class S.

Findlay turns out more high-rel CMOS devices than any other plant in the world... about 5 million per year. 1.5 micron devices are now being produced, with 1.25 and sub-micron capabilities planned for the near future. Findlay uses a Class 10 wafer processing area.

More important than the advanced equipment used at

Findlay is a stable, very experienced work force that has been engaged in high-rel IC production for two decades.

The Intersil plant in Santa Clara, California, is also certified for JAN 38510 CMOS and bipolar production. High-rel power discretes are fabricated and assembled at our very efficient Mountaintop, PA, plant.

PACKAGING

Our hermetically-sealed packages provide a protective environment for our high-rel chips.

You can choose from ceramic dual-in-line, ceramic flat packs,

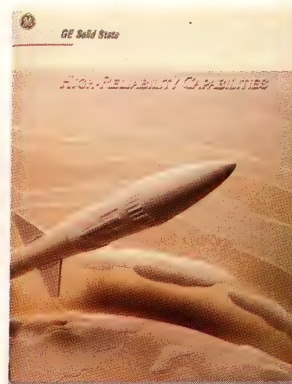
leadless chip carriers and pin-grid arrays in a variety of lead finishes.

We provide packages with up to 132 terminals or more. And we have sizes for chips as large as 400x400 mils.

YOUR STRATEGIC PARTNER

This is only a sample of what the combined forces of GE, RCA and Intersil—the new GE Solid State—can offer you. For example, our line includes CMOS bipolar and BiMOS linears; CMOS micros and peripherals; and an Emulating and Programmable Chip set that can be used to implement new architectures or to emulate existing ones.

Why not partner with the world's premier high-rel CMOS supplier? Call for a copy of our High-Reliability Capabilities brochure. 800-443-7364, extension 26.



In Europe, call: Brussels, (02) 246-21-11; Paris, (1) 39-46-57-99; London, (276) 68-59-11; Milano, (2) 82-291; Munich, (089) 63813-0; Stockholm (08) 793-9500.

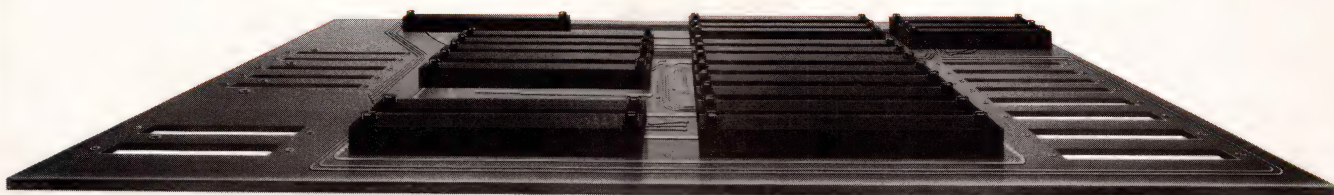


GE/RCA/Intersil Semiconductors

Three great brands. One leading-edge company.

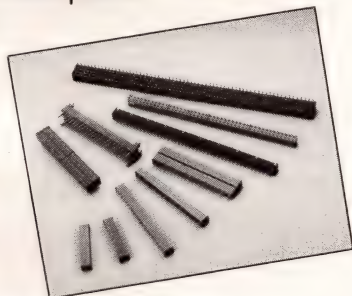
GE Solid State

THE BEST CONTACTS ACROSS THE BOARD...

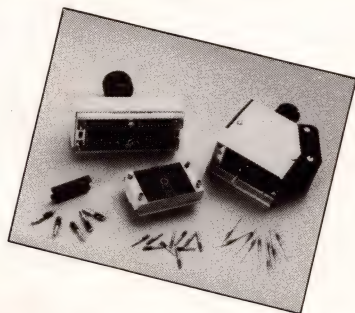


LOW INSERTION FORCE HYPERTACS®

Hypertronics' connectors feature Hypertac®, a design innovation that satisfies requirements previously considered impossible. The essence is a hyperboloid shape formed by multiple wires that stretch and wrap around the mating pin to create multiple contact paths.

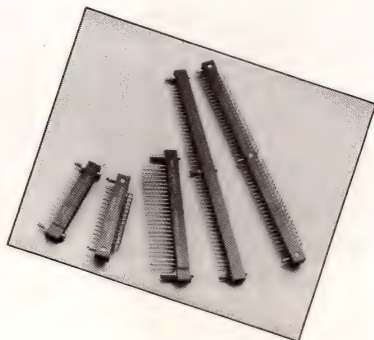


KG Series—Sub-Miniature Low Profile LIF/PCB Connectors • .100 x .100 grid from 22-90 positions • .240 height between parallel boards, sandwich style • Mother/daughter board, board to chassis and other applications • Inductance as low as 50% of comparable designs.

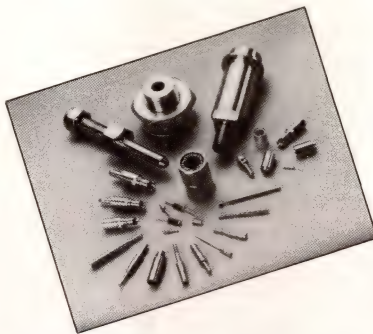


N Series—High Density LIF Mini-Modular Connectors • Design your own special connector from standard parts • 10 position—5 amp and 5 position—9 amp modules • Up to 700 contacts on a

.100 x .100 grid • Over 40,000 potential combinations for rack and panel, cable to chassis, and programming applications.



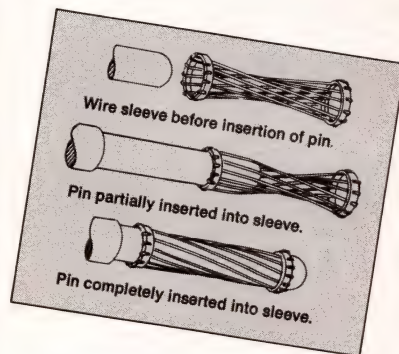
KA Series—Sub-Miniature LIF/PCB Connectors • The choice in demanding military and industrial applications • 17-320 position models with average contact insertion force of 1 ounce • Removable p.c., wire wrap, solder and crimp terminals • Integral guide and locking hardware.



Y Series—LIF Pins and Sockets • 2.5 to 200 amp standard pins and sockets • Customized p.c. or backplane mounting • Connect to cable or printed circuit boards.

All Hypertronics connectors utilize the Hypertac® design, resulting in these unique characteristics:

- extremely low contact insertion/extraction force (as low as ½ ounce).
- electrical continuity under extremes of shock and vibration (tested below 10 n.s.).
- mechanical life exceeding 100,000 cycles with excellent electrical repeatability.



Customized designs featuring the Hypertac® contact are available from Special Products Division. For more information on these versatile connectors, call Toll-Free 1-800-225-9228 or write for a copy of our brochure, "New Horizons in Connectors."



HYPERTRONICS CORPORATION

16 Brent Drive
Hudson, MA 01749
Telex: 95 1152
1-800-225-9228
Tel: (617) 568-0451
in MA & Canada

Now run on micropower without cutting corners



You wouldn't want compromises if you bought the classiest car in the world. So, we think you expect that same quality in your micropower op amp.

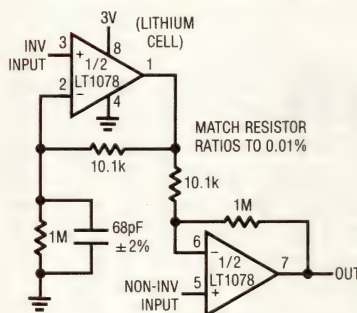
Our LT1078 dual and LT1079 quad micropower op amps are optimized for micropower operation. This means no sacrificing precision, noise, speed and output drive specifications in your 5V single supply or $\pm 15V$ applications.

We've concentrated on reducing supply current ($50\mu\text{A}$ max.) without affecting other parameters. Our $70\mu\text{V}$ max. offset voltage is the lowest for any non-chopper-stabilized dual or quad op amp, regardless of power consumption. The $1/f$ corner of the voltage noise spectrum is set at 0.7Hz —three times lower than any other monolithic op amp. You achieve a 0.1Hz to 10Hz noise performance of $0.6\mu\text{V}$ p-p found only on devices with an order of magnitude higher supply current.

Other features include: offset current of 250pA max., $0.4\mu\text{V}/^\circ\text{C}$ drift, current noise of 3pA p-p, a slew rate of $0.07\text{V}/\mu\text{s}$, gain bandwidth of 200kHz and guaranteed output drive of 5mA.

These op amps operate from low supply voltage—as low as

Single Battery, Micropower, Gain = 100, Instrumentation Amplifier



TYPICAL PERFORMANCE

INPUT OFFSET VOLTAGE = 40 μ V
 INPUT OFFSET CURRENT = 0.2nA
 TOTAL POWER DISSIPATION = 240 μ W
 COMMON MODE REJECTION = 110 dB AT DC
 = 80 dB AT 500Hz
 GAIN BANDWIDTH PRODUCT = 200kHz
 OUTPUT NOISE = 85 μ Vp-p 0.1Hz to 10Hz
 = 300 μ V_{RMS} OVER FULL BANDWIDTH
 INPUT RANGE = 0.03V to 1.8V
 OUTPUT RANGE = 0.03V to 2.3V (0.3mV $\leq V_{IN} \leq$ 23mV)
 OUTPUTS SINK CURRENT — NO PULL DOWN RESISTORS
 ARE NEEDED

one lithium cell or two Ni-cad batteries. The input common-mode range goes below ground. The all-NPN output stage swings to within a few millivolts of ground while sinking current. This means you don't need pull-down resistors to pull the output to ground. In competitive micropower op amps, the required pull-down resistors sometimes draw significantly more battery current than the entire amplifier.

Applications include battery-powered portable instruments, remote sensor amplifiers, micropower sample-and-holds and thermocouple amplifiers. The LT1078/79 also offer performance advantages in non-micropower applications.

LT1078 comes in 8-pin DIP or metal can versions, and LT1079 in a 14-pin DIP. Both military and commercial versions are available. In lots of 100, LT1078CN8 and LT1079CN op amps are priced at \$2.80 and \$3.50 each.

Stop cutting corners. Ask for the world class op amps with no tradeoffs. For details on our LT1078/79 series, contact Linear Technology Corporation, 1630 McCarthy Blvd., Milpitas, CA 95035. Or call 800-637-5545.



TOUGH PRODUCTS
FOR TOUGH APPLICATIONS.

DESIGN IDEAS

EDITED BY TARLTON FLEMING

555 timer triggers phase-control circuit

J N Lygouras

University of Thrace, Xanthi, Greece

The control circuit in **Fig 1a** allows you to manually adjust the power delivered to a load. By changing the setting of potentiometer R_3 , you change the phase angle at which the thyristor (Q_3) fires (**Fig 1b**), thereby altering the load current's duty cycle. The adjustment range is about 0 to 180°. Q_3 's off time is linear with R_3 , but of course the resulting load power is not linear with R_3 .

The full-wave diode bridge delivers pulsed-dc voltage to the load, making the circuit suitable for dc-control applications such as dimming. (The circuit can handle ac power if you substitute a triac for Q_3 and make slight modifications.)

IC_1 is a low-power—1 mW—timer configured as a monostable monovibrator. Zener diode D_1 and filter capacitor C_1 , activated by pulses from the voltage divider R_1/R_2 , form a dc supply for the timer. Q_1 turns on and applies a negative-going trigger to the timer (pin 2) each time Q_1 's base voltage approaches 0V. In response, the timer issues a positive pulse that turns on Q_2 and turns off Q_1 , removing load power for an interval equal to $1.1R_3C_2$. To increase the control resolution, you can lower the value of R_3 , substitute a potentiometer with more turns, or add a fixed resistor in series with the potentiometer.

EDN

To Vote For This Design, Circle No 750

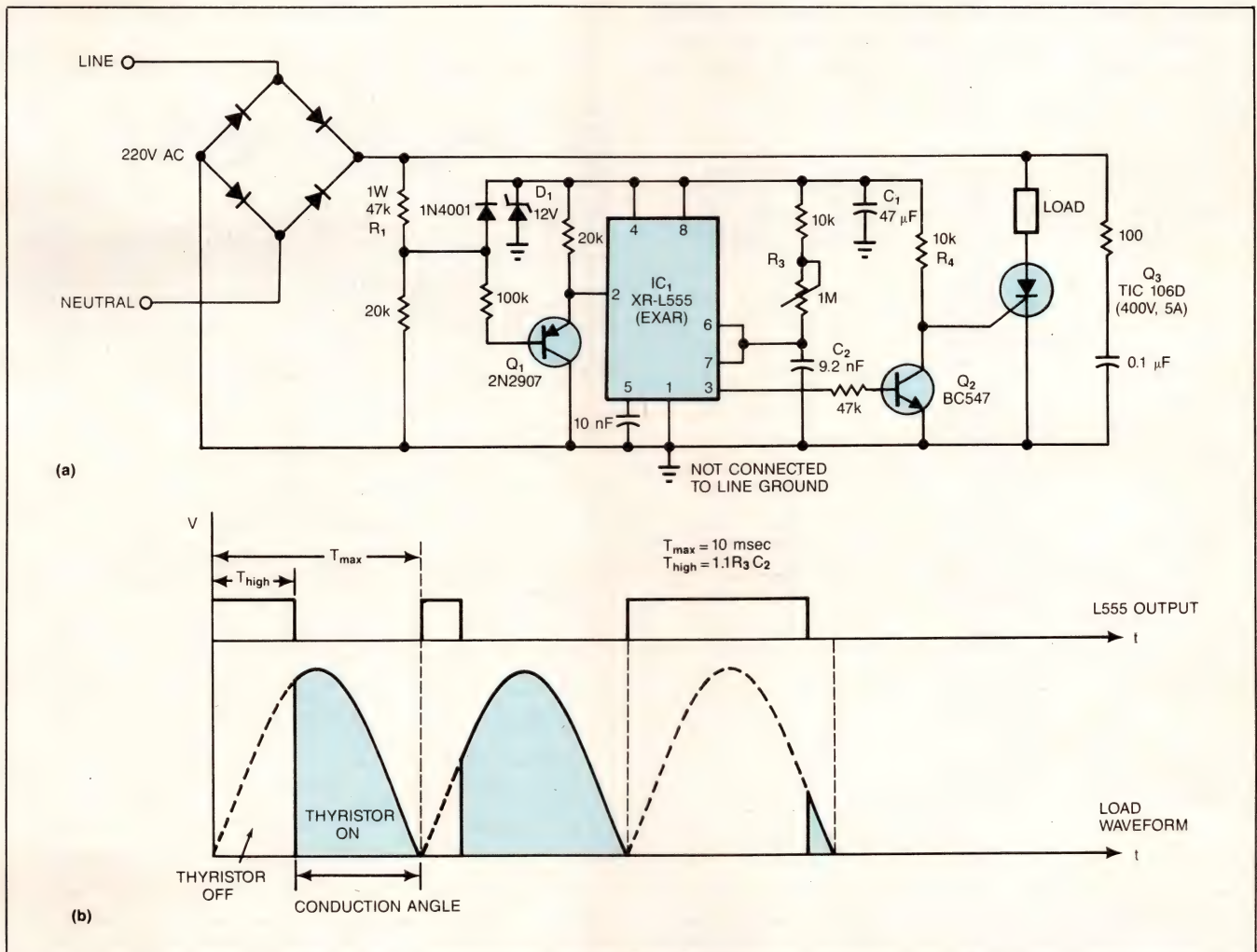


Fig 1—Adjusting this circuit's R_3 (a) varies the percent of each line cycle that power is applied to the load (b).

PWM DAC simplifies output filtering

Roy Sprowl
Litton, Chatsworth, CA

Composed entirely of logic gates, the PWM D/A converter of **Fig 1** is suitable for gate-array designs. The circuit's output signal requires less filtering than that of conventional PWM DACs. A single-pole filter, with a corner frequency (f_0) equal to $\frac{1}{20}$ th of the converter's sample rate, is sufficient to reduce the converter's output ripple to less than 1 LSB p-p. What's more, the filter requirement depends only on the sample rate and not on the converter's bit resolution. For a given level of ripple, a conventional PWM converter would require filtering in proportion to its bit resolution (**Table 1**).

Fig 2's waveforms illustrate the circuit's reduced need for filtering. A conventional PWM converter's maximum ripple occurs at half scale, where the output is a square wave at the sample frequency, but **Fig 1's** half-scale output is a square wave at 2^{n-2} times the

sample frequency. In fact, **Fig 1's** maximum ripple does not exceed $3\times$ that associated with the count 1 waveform of **Fig 2**.

Fig 1 has one potential drawback that conventional PWM D/A converters do not have. Because the rate of output transitions varies with the input code, unequal rise and fall times in the output cause a second-order nonlinearity error. This error value peaks at half scale and is most noticeable in fast or high-resolution versions of the converter.

Although the circuit is similar to a rate-multiplier IC, it has an asynchronous counter that enables its faster operation. You can scale the circuit for other bit resolutions; for an n -bit counter, the bit resolution equals $n+1$ bits. The n input bits are B_0 - B_4 (in this case), and f_{CLK} is a square wave at 2^{n-1} times the sample rate. **EDN**

To Vote For This Design, Circle No 748

TABLE 1—FILTER FREQUENCIES FOR 1-LSB P-P RIPPLE

CONVERTER TYPE	Low-Ripple	PWM	PWM	PWM	PWM	PWM
RESOLUTION	n-bit	4-bit	6-bit	8-bit	10-bit	12-bit
f_0 / f_{SAMPLE}	1/18.8	1/23.5	1/99	1/400	1/1600	1/6400
RIPPLE FREQUENCY	$\times 1$	$\times 1.25$	$\times 5.2$	$\times 21.3$	$\times 85$	$\times 340$

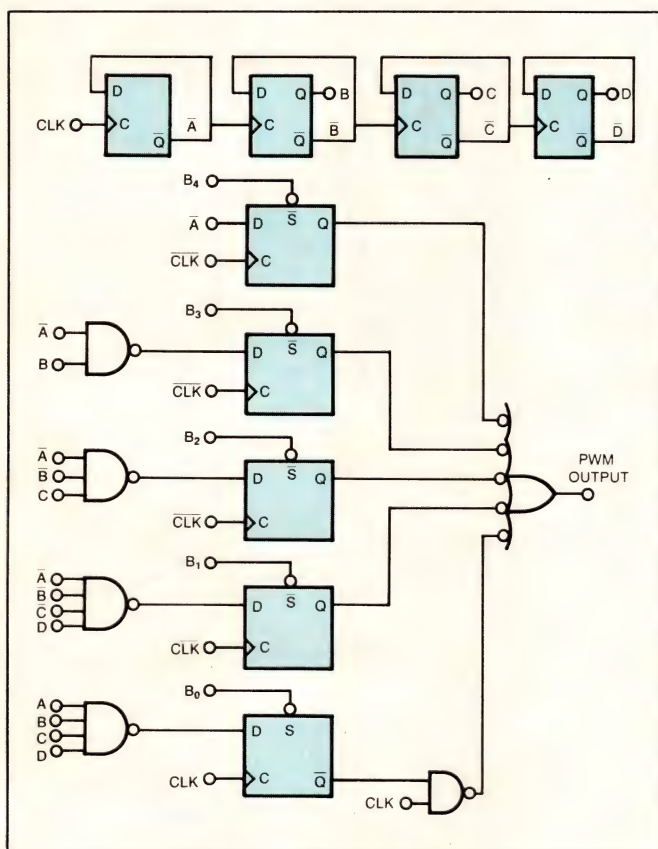


Fig 1—This logic-gate PWM D/A converter requires only a single-pole filter to produce an output with 1-LSB ripple. You make the connections indicated between the counter outputs shown at the top and the left-side input terminals.

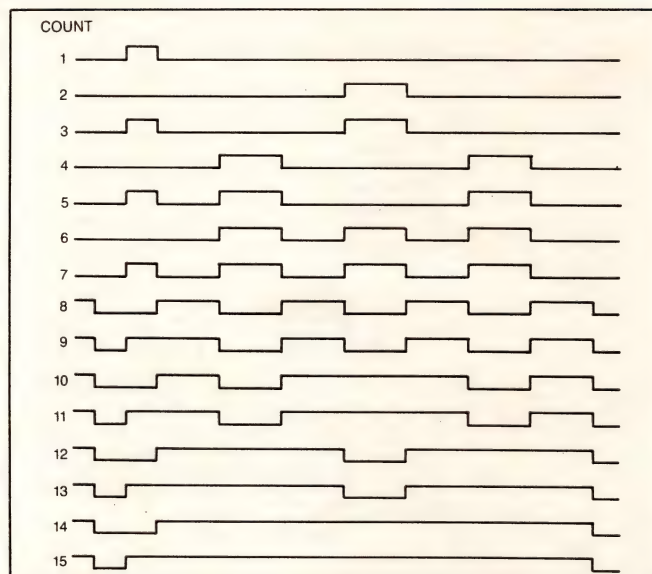
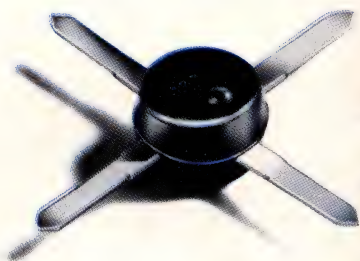


Fig 2—Fig 1's circuit produces these output waveforms in response to the counter's 16 output codes.

99¢

from



dc to 2000 MHz amplifier series

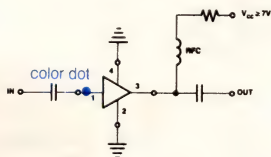
SPECIFICATIONS

MODEL	FREQ. MHz	GAIN, dB				•MAX. PWR. dBm	NF dB	PRICE \$	
		100 MHz	1000 MHz	2000 MHz	Min. (note)			Ea.	Qty.
MAR-1	DC-1000	18.5	15.5	—	13.0	0	5.0	0.99	(100)
MAR-2	DC-2000	13	12.5	11	8.5	+3	6.5	1.50	(25)
MAR-3	DC-2000	13	12.5	10.5	8.0	+8□	6.0	1.70	(25)
MAR-4	DC-1000	8.2	8.0	—	7.0	+11	7.0	1.90	(25)
MAR-6	DC-2000	20	16	11	9	0	2.8	1.29	(25)
MAR-7	DC-2000	13.5	12.5	10.5	8.5	+3	5.0	1.90	(25)
MAR-8	DC-1000	33	23	—	19	+10	3.5	2.20	(25)

NOTE: Minimum gain at highest frequency point and over full temperature range.

- 1dB Gain Compression
- +4dBm 1 to 2 GHz

designers amplifier kit, DAK-2
5 of each model, total 35 amplifiers
only **\$59.95**



Unbelievable, until now...tiny monolithic wide-band amplifiers for as low as 99 cents. These rugged 0.085 in.diam., plastic-packaged units are 50ohm* input/output impedance, unconditionally stable regardless of load*, and easily cascable. Models in the MAR-series offer up to 33 dB gain, 0 to +11 dBm output, noise figure as low as 2.8dB, and up to DC-2000MHz bandwidth.

*MAR-8, Input/Output Impedance is not 50ohms, see data sheet.
Stable for source/load impedance VSWR less than 3:1

Also, for your design convenience, Mini-Circuits offers chip coupling capacitors at 12 cents each.†

Size (mils)	Tolerance	Temperature Characteristic	Value
80 x 50	5%	NPO	10, 22, 47, 68, 100, 470, 680, 100 pf
80 x 50	10%	X7R	2200, 4700, 6800, 10,000 pf
120 x 60	10%	X7R	.022, .047, .068, .1μf

† Minimum Order 50 per Value

finding new ways ...
setting higher standards

Mini-Circuits

A Division of Scientific Components Corporation
P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500
Fax (718) 332-4661 Domestic and International Telexes: 6852844 or 620156

C113-Rev. D

Add text to composite-video signal

Stephen Tomporowski
Philips Medical Systems Inc, Shelton, CT

The Fig 1 circuit shows a simple way to add text information to a composite-video signal that may be floating at some indeterminate dc level. The text generator and composite-video source must have the same sync signal.

The video-input and -output signals share the same terminal. C_3 couples the video signal to the output of a rectifier circuit that is based on a subvideo-speed op amp. (A faster op amp would clamp on individual sync pulses rather than on the video waveform's average value, as is desired.) C_3 accommodates applications in which the video blanking level is negative (below ground). By adding a second electrolytic capacitor in series, with their negative leads connected, you can eliminate the circuit's sensitivity to the polarity of the

video signal's dc component. R_{11} serves as a pulldown resistor, and feedback resistor R_{10} ensures that TP6 remains at ground level.

Emitter follower Q_1 buffers the text signal, and R_5 serves as a gain control. A simple clamp circuit (Q_2) is sufficient for regulating amplitude because the text signal contains no gray-scale levels. Q_3 couples the text signal into the op-amp clamp circuit. Although a sync-driven clamp would offer higher performance, this type of circuit performs the function required of it—preventing the addition of text from creating a hump or a dip in the video waveform's blanking level. Such aberrations produce unsightly light or dark bars across the monitor screen's text display.

EDN

To Vote For This Design, Circle No 747

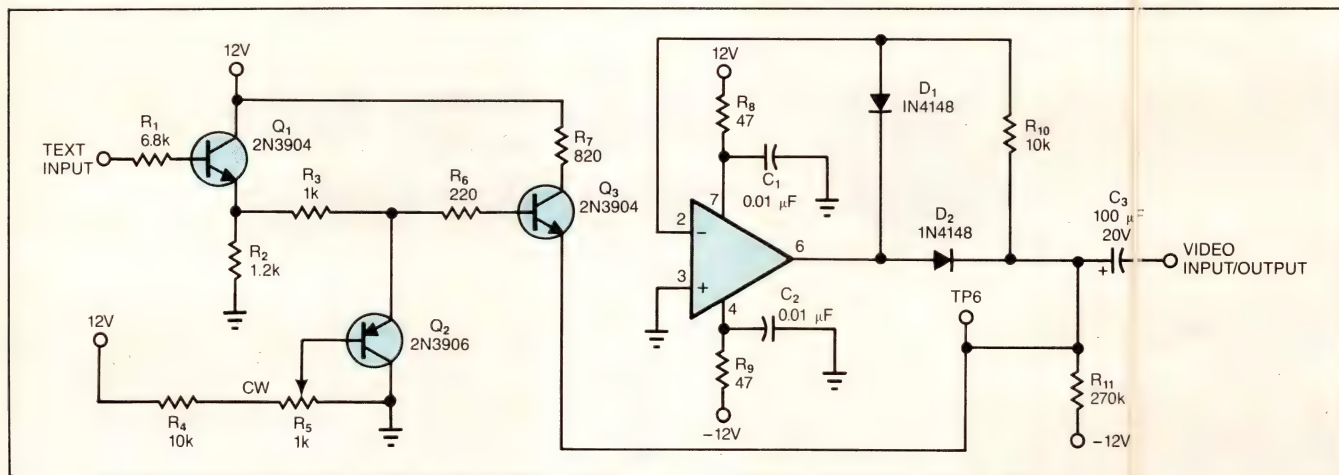


Fig 1—This circuit adds a text-information signal to a composite-video signal of indeterminate dc level.

First-order allpass filter uses an MF10

Kevin Hoskins
National Semiconductor Corp, Santa Clara, CA

You can use a first-order allpass filter to provide compensation for closed-loop control systems, or to remove

the ringing on transmitted square waves by compensating for the transmission line's nonideal phase shift. In addition, you can use such a filter for motor control by creating a quadrature oscillator that generates sine and cosine waveforms. Fig 1a shows a conventional first-

Z I L O G



The creator's setting the new standard. Again.

Zilog's NMOS SCC is the clearly established industry standard. Now our CMOS SCC, the Z85C30, brings you all the low power, low temperature, high reliability advantages of CMOS technology—and more. Off the shelf. It's the new design and upgrade opportunity you've been waiting for.

Impressive performance.

Along with the tremendous performance benefits of having an SCC in CMOS, you'll get greatly increased speeds. Maximum data rates of 2.5 Mb/sec, for example. And the on-board 10x19-bit status FIFO and 14-bit byte counter ensure high-speed SDLC transfer. Plus the CMOS SCC's enhanced DMA support cuts your CPU overhead considerably, so you don't have to babysit the device.

Easy to design in. Pin compatible upgrade.

Zilog's CMOS SCC easily interfaces to multiplexed or non-multiplexed microprocessors. The Z85C30 is function compatible—software compatible and pin compatible—with the industry standard NMOS SCC. So all you have to do is plug it in.

Quality and reliability you can count on.

Using Zilog's advanced 2 micron CMOS manufacturing process, we're currently achieving better than 100 PPM on the Z85C30. With over 4000v ESD protection, the device has a very high immunity to EMI and static-induced stress. And the CMOS SCC is available in MIL Standard 883C for even more reliability assurance.

We wrote the book on SCCs.

Zilog's NMOS SCC is widely used by the industry's top names in system manufacturing. Our original SCC literature is the book that much of rest of the industry has used as a source. We offer a full complement of support materials including application notes and a list of detailed answers to the most commonly asked questions.

We've got lots more to tell you about the CMOS SCC. Not to mention some other very exciting Zilog SCCs, including the soon-to-be-released SMART SCC and INTEGRATED SCC. All off the shelf and backed by Zilog's proven quality and reliability. Enough said. Contact your local sales office or your authorized distributor today. Zilog, Inc., 210 Hacienda Ave., Campbell, CA 95008, (408) 370-8000.

Right product. Right price. Right away. **Zilog**

ZILOG SALES OFFICES: CA (408) 370-8120, (714) 838-7800, (818) 707-2160. **CO** (303) 494-2905, **FL** (813) 585-2533, **GA** (404) 923-8500, **IL** (312) 885-8080, **MA** (617) 273-4222, **MN** (612) 831-7611, **NJ** (201) 288-3737, **OH** (216) 447-1480, **PA** (215) 653-0230, **TX** (214) 231-9090, **CANADA** Toronto (416) 673-0634, **ENGLAND** Maidenhead (44) (628) 39200, **W. GERMANY** Munich (49) (89) 67-2045, **JAPAN** Tokyo (81) (3) 587-0528, **HONG KONG** Kowloon (852) (3) 723-8979. **R.O.C.:** Taiwan (886) (2) 731-2420, **U.S. AND CANADA DISTRIBUTORS:** Anthem Electric, Bell Indus., Hall-Mark Elec., JAN Devices, Inc., Lionex Corp., Schweber Elec., Western Microtech., CANADA Future Elec., SEMAD.

DESIGN IDEAS

order allpass circuit using an RC network and an op amp; **Fig 1b** shows an equivalent circuit based on $\frac{1}{2}$ of an MF10 dual switched-capacitor filter. (If you don't need the other $\frac{1}{2}$ of the filter section, use an MF5 single-section filter instead.)

For both **Fig 1** circuits, the phase response begins with 0° phase at dc, becomes 90° at the center frequency (f_0), and approaches 180° as the input frequency increases. Just as you would expect for an allpass-filter response, neither of the circuits alters the input amplitude. **Fig 1a**'s transfer function, normalized to $\omega=1$, is

$$\frac{V_{OUT}}{V_{IN}} = -\frac{s-1}{s+1}$$

Fig 1b's realization of this function duplicates **Fig 1a**'s noninverting path by routing the input signal to pin 5, through the first integrator, through R_3 , and back into pin 4. **Fig 1b**'s corresponding inverting path consists of the MF10's op amp, R_2 , and R_1 . The normalized transfer function for **Fig 1b** is

$$\frac{V_{OUT}}{V_{IN}} = \frac{-1 \left(\frac{sR_2}{R_1} - \frac{R_2}{R_3} \right)}{s + \frac{R_2}{R_3}}$$

Setting $R_1=R_2=R_3=10 \text{ k}\Omega$ reveals the similarity of **Fig 1b**'s transfer function to the **Fig 1a**'s transfer function:

$$\frac{V_{OUT}}{V_{IN}} = \frac{-1(s-1)}{s+1}$$

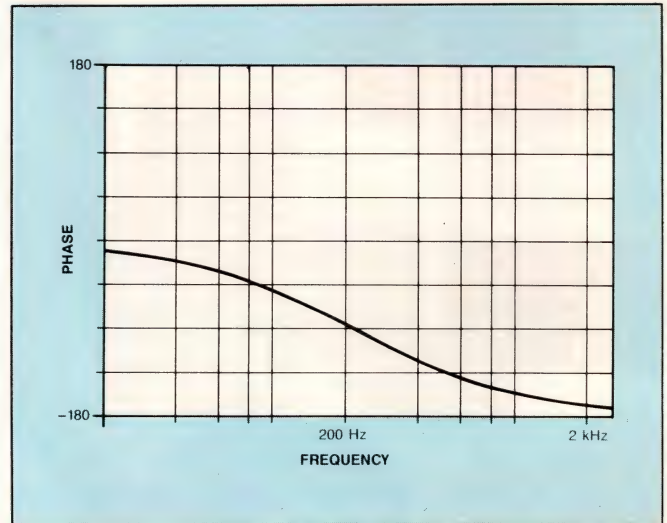


Fig 2—The phase response for **Fig 1b** shows -90° at f_0 (210 kHz).

Fig 2 shows the phase response of the **Fig 1b** circuit when $f_{CLK}=210 \text{ kHz}$. When the circuit uses 1% resistors, the amplitude response is flat to within $\pm 0.3 \text{ dB}$. The center frequency equals $f_{CLK}/50$ or $f_{CLK}/100$, depending on the connection to pin 12. You can change f_0 simply by changing f_{CLK} . Note that **Fig 1b** also provides a first-order lowpass-filter output at pin 2, with a gain of -2 . This output's $-3\text{-dB } f_0$ is the same as that of the allpass-filter output— $f_{CLK}/50$ or $f_{CLK}/100$. **EDN**

To Vote For This Design, Circle No 746

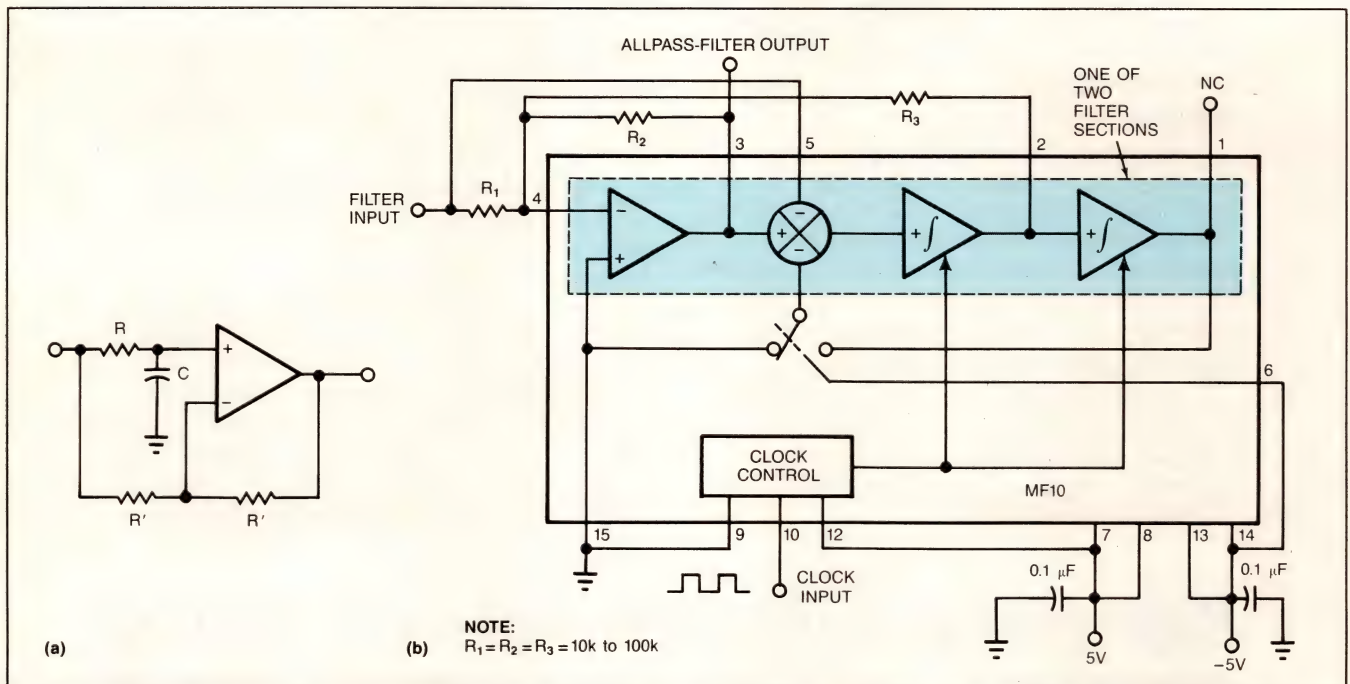
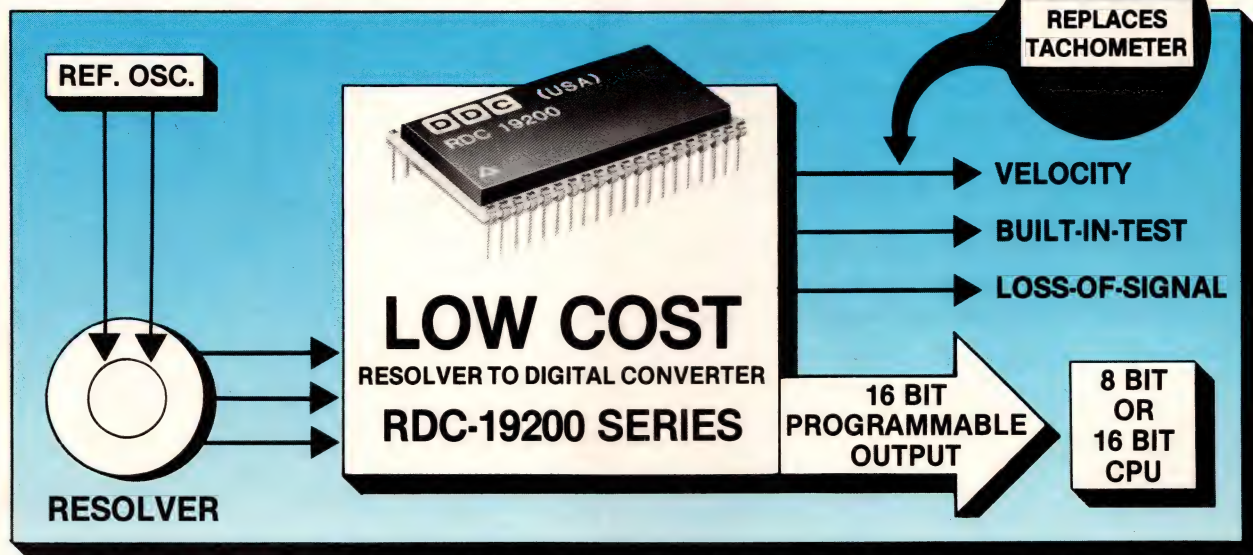


Fig 1—The op amp circuit (a) and the switched-capacitor-filter IC (b) both provide a first-order, allpass-filter response.

ABOUT SYNCHRO-CONVERSION • A/D & D/A CONVERSION • 1553 BUS DEVICES • POWER & CUSTOM HYBRIDS

LOW COST MOTION CONTROL R/D NOW HAS TACH OUTPUT



DDC's RDC-19200 series of resolver to digital converters are low cost, fully self-contained units with high accuracy, a tachometer-like output signal and programmable bandwidth and resolution. Offering significant benefit to motion control designs, the RDC-19200 series also provides useful output signals such as Built-In-Test, Loss-of-Signal and Major Carry (for turns counting), and a flexible microprocessor interface. Based on a proprietary custom monolithic, the converter is packaged in a small 40 TDIP hybrid and is ideal for the most demanding position and velocity sensing applications.

The high quality Velocity output signal provided by the RDC-19200 is a ground based voltage of 0 to ± 10 VDC and is linear to 0.7%. This signal, whose output voltage is externally scalable, can be used to eliminate the tachometer that is often required for tight loop control in high performance motion

control systems. Another unique benefit is the programmable resolution, which provides precise positioning (16-bit mode) and fast tracking (10-bit mode) in the same component.

Use of a custom monolithic LSI chip has significantly reduced the component count in the RDC-19200 series and thereby increased the reliability of the unit, as well as its accuracy (to 2.3 arc minutes). A single logic input line provides the user with control over the converter bandwidth. It may be set at either 130 Hz or 530 Hz. The RDC-19200 series is available in models for 11.8VRMS resolver input and 2VRMS direct input. Temperature range of operation is 0 to $+70$ degrees.

The RDC-19200's Built-In-Test output signal is quite useful for system fault detection. It provides an output indication when input signal is lost, when reference signal is lost, and when the input angular

change exceeds the converter's maximum tracking rate. The digital output interface is very flexible, and easy to use with most popular microprocessors. Data transfers are made without disturbing the converter's tracking of the input angle. The digital output is buffered with a transparent tri-state latch, and may be transferred in either one or two bytes.

DDC's RDC-19200 series are designed to provide versatility to industrial motion control systems including motor controls, CNC machine tools, and robot axis controls. **To learn more about DDC's RDC-19200 call the DDC office nearest you.** □

**CERTIFIED AND
QUALIFIED TO
MIL-STD-1772**



**ILC DATA DEVICE
CORPORATION**

HEADQUARTERS AND MAIN PLANT: ILC Data Device Corporation, 105 Wilbur Place, Bohemia, N.Y. 11716, (516) 567-5600, TLX: 310-685-2203, FAX: 516-567-7358
WEST COAST (CA): WOODLAND HILLS, (818) 992-1772, TWX: 910-499-2674;
 SANTA CLARA, (408) 244-0831, TLX: 172775; HUNTINGTON BEACH, (714) 840-5723
WASHINGTON, D.C. AREA: (703) 893-7989, TWX: 910-997-0967
NORTHERN NEW JERSEY: (201) 785-1734, TLX: 130-332
MASSACHUSETTS: (617) 341-4422 or 3128, FAX: (617) 344-1040; **JAPAN:** (03) 814-7688, FAX: (03) 814-7689
UNITED KINGDOM: 635-40158, TLX: 851-848826; **FRANCE:** (1) 4-333-5888, TLX: 842-630609
WEST GERMANY: (08191) 3105, TLX: 841-527128; **SWEDEN:** 8-920-635, TLX: 854-10952

Motor controller eliminates tachometer

Barry Friedman
Copley Controls, Newton, MA

Precision motion-control systems use a motor-driven tachometer to generate electronic feedback for the motor's servoamplifier in order to attain 0.1% accuracy. If your application can tolerate 2 to 3% errors, however, you can reduce cost and complexity by eliminating the tachometer and using the servomotor's own back-EMF voltage as a feedback signal instead.

A simple model of the servomotor (Fig 1) shows the back EMF (V_e) as a voltage source in series with the armature winding's resistance and inductance. You can

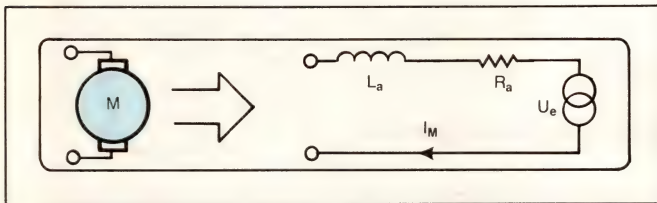


Fig 1—A first-order model of a servomotor includes the motor's armature inductance (L_a), armature-winding resistance (R_a), and back-EMF source (V_e).

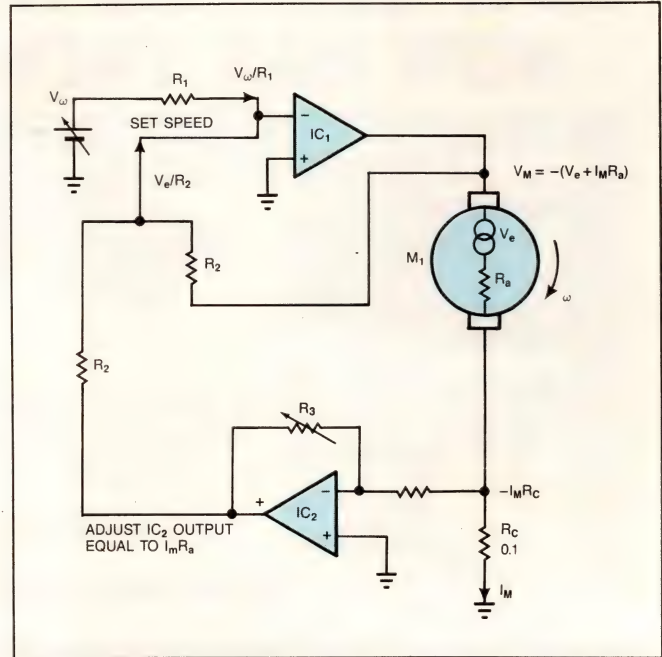


Fig 2—This generalized schematic illustrates the principle of using V_M as a feedback signal, after first subtracting the motor armature's error-producing IR drop.

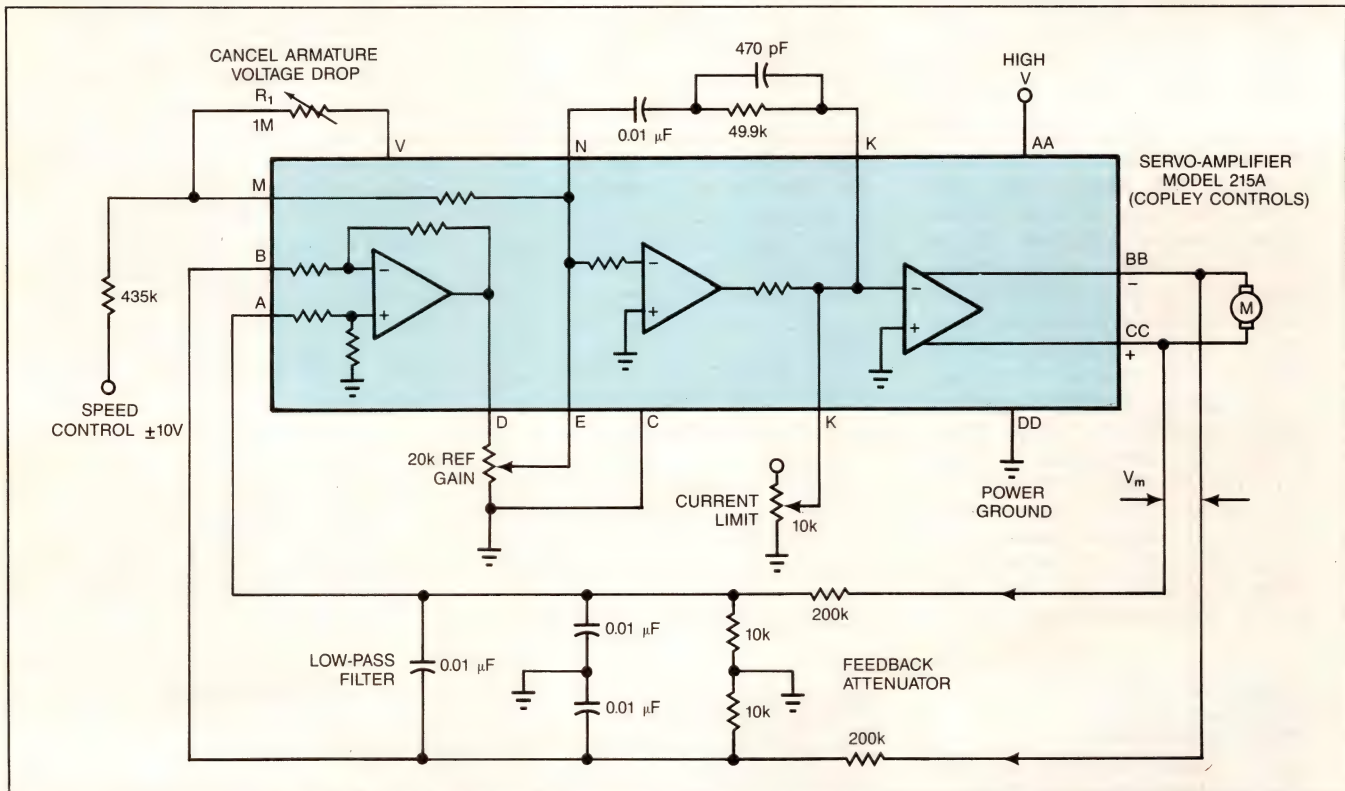


Fig 3—This circuit uses the Fig 2 approach and makes use of a current-sensing circuit internal to the servoamplifier.

LEADER



“At lunch today, I learned to use this programmable video generator. And still had time to eat.”

While other RGB video generators take weeks to learn, ours take minutes. No digital training needed. No countless key combinations to learn. No need to use your PC unless you want to. Unlike other generators, Leader's have an integral programmer (LVG-1604A and 1603A) or are available with a programmer unit (1601A). And you can get any of dozens of test patterns simply by touching one clearly marked key.

All the functions you need.

The LVG-1604A lets you test even the most advanced high-resolution CRT's and

wide-band video transmission systems. Present or future.

Analog, TTL and ECL outputs. 125 MHz. 64-color capability. Storage of up to 200 display formats. Wide range of raster architectures, and most common test patterns with both stock and user-designed characters. Ability to change format conditions. These features are easy to learn—but hard to beat.

Now you can choose.

You shouldn't pay for more functions than you need. So call us for a free copy of our full-line catalog. Pick the video generator

that's right for you. Then, in just 30 minutes, we'll show you how to use it. It'll be up and running before you finish your lunch.

Call toll-free
1 800 645-5104
In NY State
516 231-6900

Leader Instruments Corporation
380 Oser Avenue, Hauppauge, New York 11788
Regional Offices:
Chicago, Dallas, Los Angeles, Boston, Atlanta
In Canada call Omnitronix Ltd. 416 828-6221

LEADER
FOR PROFESSIONALS WHO KNOW
THE DIFFERENCE



Select a Leader Video Generator with all the features you need.

Design Entry Blank

\$100 Cash Award for all entries selected by editors. An additional \$100 Cash Award for the winning design of each issue, determined by vote of readers. Additional \$1500 Cash Award for annual Grand Prize Design, selected among biweekly winners by vote of editors.

To: Design Ideas Editor, EDN Magazine
Cahners Publishing Co
275 Washington St, Newton, MA 02158

I hereby submit my Design Ideas entry.

Name _____

Title _____ Phone _____

Company _____

Division (if any) _____

Street _____

City _____ State _____ Zip _____

Design Title _____

Home Address _____

Social Security Number _____

(Must accompany all Design Ideas submitted by US authors)

Entry blank must accompany all entries. Design entered must be submitted exclusively to EDN, must not be patented, and must have no patent pending. Design must be original with author(s), must not have been previously published (limited-distribution house organs excepted), and must have been constructed and tested.

Exclusive publishing rights remain with Cahners Publishing Co unless entry is returned to author or editor gives written permission for publication elsewhere.

In submitting my entry, I agree to abide by the rules of the Design Ideas Program.

Signed _____

Date _____

ISSUE WINNER

The winning Design Idea for the May 26, 1988, issue is entitled "Tachometer circuit reduces parts count," submitted by William McClelland of Stahl Research (Port Chester, NY).

Your vote determines this issue's winner. All designs published win \$100 cash. All issue winners receive an additional \$100 and become eligible for the annual \$1500 Grand Prize. **Vote now**, by circling the appropriate number on the reader inquiry card.

ignore the inductance for steady-state conditions, but the armature current flowing in R_a creates a voltage error in series with V_e . Consequently, the voltage across the armature terminals ($V_e + I_M R_a$) represents pure back EMF only for zero armature current (as, for example, when you turn off the power and let the motor coast to a stop).

Fig 2 shows a circuit that subtracts the error term $I_M R_a$ from the motor voltage V_M , leaving only the desired V_e term for use as a feedback signal. The current-sense resistor, R_C , enables op amp IC_2 to generate the $I_M R_a$ -cancellation voltage; feedback resistor R_3 lets you calibrate the system by adjusting that voltage. The servoamplifier, IC_1 , then produces the drive voltage (V_M) by summing the currents proportional to $I_M R_a$, V_M , and the command variable V_ω :

$$\frac{V_\omega}{R_1} = \frac{V_e}{R_2} \Rightarrow V_e = V_\omega \frac{R_2}{R_1}$$

Fig 3's implementation of this approach incorporates a specific servoamplifier. Because products such as this one, the Copley Controls Model 215A, deliver a differential output (V_M) as high as 150V, you must attenuate the feedback signal with resistive dividers (200 k Ω to 10 k Ω for this example). This type of amplifier also achieves high efficiency by delivering a PWM output. To produce an analog-equivalent signal suitable for feedback to the servoamplifier's input, you need a simple lowpass filter, which you can achieve by adding 0.01- μ F capacitors to the resistor network already in place.

The servoamplifier includes a current-sensing circuit normally used for the remote indication or control of torque, which enables it to cancel the motor armature's $I_M R_a$ term with the help of an external 1-M Ω potentiometer (R_1). R_1 also controls the degree of positive feedback (damping). You should set the potentiometer to its maximum value, and then adjust the system for optimum speed stability by gradually decreasing the resistance setting.

EDN

To Vote For This Design, Circle No 749

Introducing OmniLab 9240.

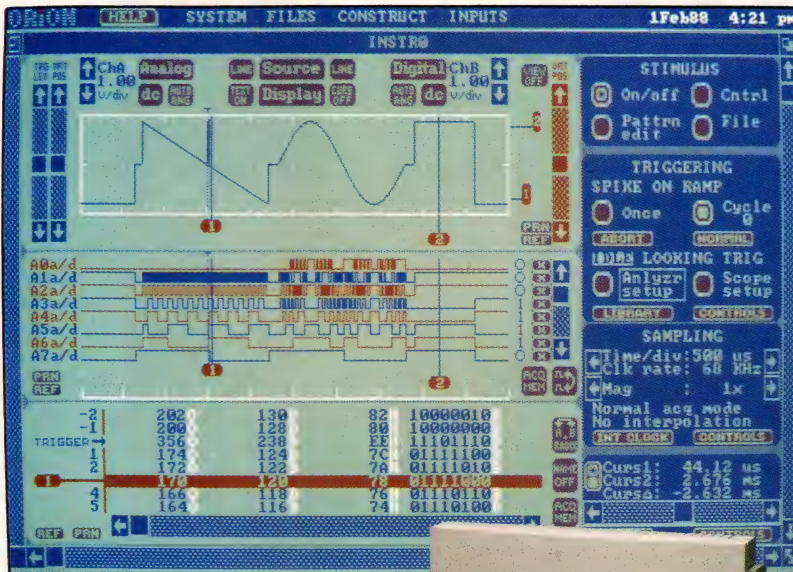
Totally Integrated Scope-Analyzer-Stimulus.

■ Combine a 100 MHz digital oscilloscope with a time-aligned, 200 MS/s 48-channel logic analyzer. Next add synchronized analog and digital stimulus generators. Then a remarkable new triggering system. What you have is the 9240 — a whole **new class** of instrumentation. Expressly designed to speed challenging analog and digital analysis. And get you from concept to product faster.

■ The 9240 is based on an innovative new instrument architecture that merges high-speed universal hardware and seamlessly-integrated software to create high-performance capabilities not available in separate instruments. Analog and digital traces are always time-correlated in a unique, single screen display. SELECT™ triggering bridges scope and analyzer techniques. And OmniLab's stimulus generators can playback captured or edited signals.

■ At the heart of the 9240 is SELECT triggering, the most straightforward and complete solution **ever** to triggering dilemmas. It's one system, operating with synchronized analog and digital views of your data. By combining conventional oscilloscope and analyzer triggering with powerful RAM truth tables — plus min/max time qualification as needed — SELECT triggering helps you analyze hardware, debug software, and integrate systems more easily.

■ OmniLab™ is a generation ahead of conventional digital scopes that often hide rarely occurring faults because they only show you a few cycles out of millions. With its continuous monitoring, you can use SELECT triggering to quickly catch every occurrence



OmniLab display demonstrates capture of an imbedded analog glitch (in top trace) with time-aligned presentation of the waveform's digitized bit values (center) and numeric states.



of rare events like metastable states, bus contentions, missing pulses, and buried noise glitches.

■ The 9240 is like having a complete benchtop of instruments integrated with your PC/AT or compatible. Which you can easily customize for digital development, analog development, or a combination of both.

■ With OmniLab, your productivity will soar. Because you achieve results with fewer instruments. And in fewer steps than ever before. By no means least, the 9240 delivers the best price/performance you'll find anywhere, costing just \$8900 fully outfitted. And most importantly, without compromising a single high-performance spec. Not a one.

■ For more information, call toll free **800/245-8500**. In CA: 415/361-8883. Or write for complete literature.

ORION
INSTRUMENTS

702 Marshall Street, Redwood City, CA 94063
TELEX: 530942 FAX: 415/361-8970

Computer Integrated Instrumentation

*OmniLab, and SELECT are trademarks of Orion Instruments, Inc.

NO-COMPROMISE 9240 SPECIFICATIONS

DIGITAL OSCILLOSCOPE

Digitizers: Two, 8 bit
Bandwidth: 100 MHz
Single-Shot Digitizing: 34 S/s to 204 MS/s
Repetitive Sampling: 680 MS/s
Scale Factor: 5 mV/div to 10V/div in 1-2-5 sequence
Record Length: 4K (16K, 64K optional)

LOGIC ANALYZER

Inputs: 48, timing and state
Asynchronous Clocking: 34 MS/s on 48 inputs; 204 MS/s on 8 inputs
Repetitive Sampling: 680 MS/s on 48 inputs
Synchronous Clocking: 0 to 34 MS/s
Acquisition Memory: 4K samples (16K, 64K optional)
Disassembly Options: Over 150 microprocessors

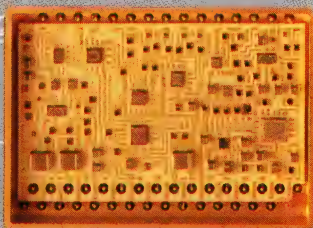
ANALOG STIMULUS

Output: 8mV to 8 V peak-to-peak, 8 bit
Cycle Length: 4 to 4K samples (16K optional)
Clocking: 34 S/s to 34 MS/s
Functions: Record, edit and playback

DIGITAL STIMULUS

Outputs: 24, 74F tri-state drivers
Cycle Length: 4 to 4K samples (16K optional)
Timing: 34S/s to 34MS/s
Functions: Record, edit and playback

NOW CERTIFIED TO MIL-STD-1772



THE HYTEK SOLUTION: HYBRIDS FROM START TO FINISH



At HYTEK microsystems, we believe that one vendor should be able to meet all of your custom hybrid circuit needs—from Computer Aided Design to finished manufacturing in any volume you need. That's why, over the past 14 years, we've developed the industry's most complete hybrid manufacturing capability for our commercial and industrial customers.

Recent **MIL-STD-1772** certification of our Carson City, Nevada Military Products Division emphasizes this capability and extends it to military contractors requiring products manufactured in a facility audited and certified by **DESC**.

FROM START

CAD/CAE DESIGN CENTER

- Fast turn around—circuit schematic to hybrid layout
- Computer generated artwork

COMPLETE SUBSTRATE PREPARATION

- CO₂ laser scribing and drilling
- Automated print and fire
- Computer controlled laser trimming

AUTOMATED ASSEMBLY

- Computer controlled die attach and wire bond for repeatability and throughput
- Military products assembled in Class 1000 clean room

TO FINISH

PACKAGING AND TESTING

- Inspected in conformance with **MIL-STD-883C**
- Wide range of package types
- Environmental and performance testing

FAST RESPONSE

Talk to us today about your hybrid circuit requirements from design to manufacturing. We serve your needs from **START TO FINISH**.

THAT'S THE HYTEK SOLUTION

HYTEK microsystems Inc.

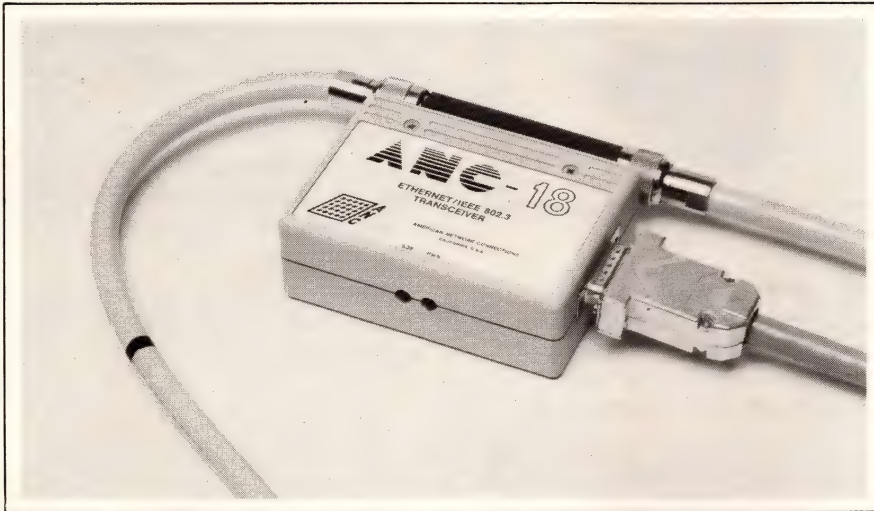
980 University Avenue, Los Gatos, CA 95030

TEL (408) 395-2300, FAX (408) 395-9677



NEW PRODUCTS

COMPONENTS & POWER SUPPLIES



TRANSCEIVER

- Connects to a standard Ethernet coaxial cable
- Features proper operation and power indicators

The ANC-18 transceiver connects standard Ethernet-coaxial (10-BASE5) or thin-coaxial (10-BASE2) cable with a choice of three taps—AMP piercing, N-type, and BNC-type. It is designed to comply with Ethernet V2/IEEE

802.3 transceiver specifications and 10M-bps Ethernet CSMA/CD operation. The unit features two indicators for operation and power statuses and is housed in a die-cast aluminum case. The units are UL, CSA, TUV, and FCC certified. \$280.

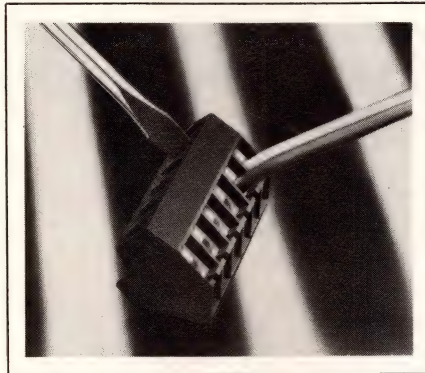
American Network Connections Inc., 462 Oakmead Parkway, Sunnyvale, CA 94086. Phone (408) 737-1511. TWX 650-334-0732.

Circle No 370

TERMINAL STRIPS

- Save space on crowded pc boards
- Captive protectors hold wires securely in place

With 0.197-in. contact spacing, Eurostyle 45° entry terminal strips save space while providing easy, safe access for wiring on crowded pc boards. In addition to a small footprint and easy wire access, the terminals have touch-proof recessed terminals and wire-ready captive screws that won't fall out and cause shorts. The terminal strips carry a 15A UL-recognized current rating and will accommodate voltages to 300V. Other features include a large wire-entry design that will accept 14 AWG wires, a closed side that acts as a wire stop, and thermoplas-



tic insulator material that has a 130°C temperature index and carries a 94V-0 UL flame-retardant rating. \$0.18/circuit (500).

Vernitron Corp., Beau Products Div, Box 10, Laconia, NH 03247. Phone (603) 524-5101. TWX 710-364-1843.

Circle No 371

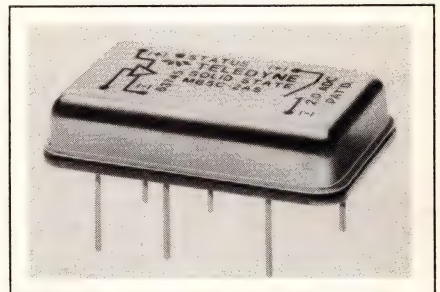
LASER DIODES

- Designed for long-haul applications
- Feature 0.2-nsec response time

DFB laser diodes are designed for long-haul, high-speed communications applications. Available in hermetically sealed metal packages, the diodes feature a typical side-mode suppression ratio of 33 dB. They operate in a stable transverse mode and feature a 0.2-nsec pulse-response time. All six devices in the line have a 20-mA typ operating threshold current and output 5 mW typ. Three of the units—ML7912, ML7612, and ML7702—operate at a 1310-nm optical wavelength. The ML9912, ML9612, and ML9702 feature a 1550-nm output wavelength. \$1787 to \$2112.

Mitsubishi Electronics America Inc., 1050 E Arques Ave, Sunnyvale, CA 94086. Phone (408) 730-5900.

Circle No 372

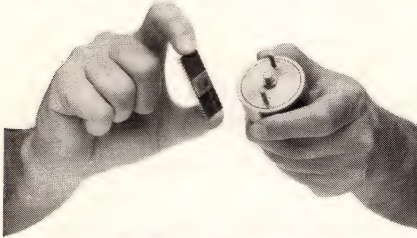


SOLID-STATE RELAY

- Features output-status feedback
- Senses a short-circuit condition and shuts down

The M85C-2AS solid-state relay features true output-status feedback as well as short-circuit and current-overload protection. An output-status pin indicates that the output is on and conducting current. The short-circuit protection provided will sense a short-circuit condition and initiate a shutdown within 5

Solenoid control design tips



Microprocessor turns snap action solenoid into a smooth positioner. It's quiet, too. See below.

Solenoids are used to control the performance of devices such as valves, gates, and dampers. New research and development provides better design capability over solenoid parameters and characteristics to make them a system designer's dream come true. Designers are specifying solenoids in applications that once used other actuators.

1

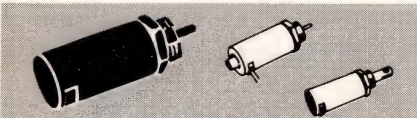
Some hot solenoid applications

- Variable, repeatable positioner
- Fly-by-wire
- High speed liquid metering
- Safe-arm locks
- Fuel injection

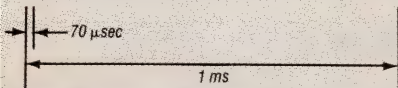
2

Design benefits

The simpler control required by solenoids means faster product development cycles, higher reliability from fewer interfaces, high force and speed capabilities. A solenoid is practically made for digital control because it's a pulsed device. And its few components can be optimized.



Example: Want higher speed actuation than a given solenoid allows? Consider using two or more smaller, faster solenoids and take advantage of their multiplied force.



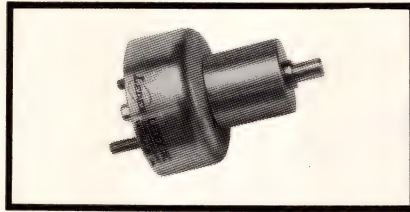
Example: A designer wanted a solenoid to operate within a millisecond, in a window only 70 microseconds wide. With a specified life of 500 million cycles! Lucas Ledex solenoids are repeatable, predictable, reliable.

3

Workhorse.

Lucas Ledex Soft Shift™ variable positioning solenoid starting force is 3 to 5 times conventional, using the same power. It can actuate in milliseconds, or its plunger velocity can be controlled smoothly and noiselessly if you ramp

the input current. Used as a hydraulic valve actuator, you can eliminate hydraulic shock.



Soft Shift™ solenoid. Stock models in five sizes.

4

Solenoid package size

Need low profile? Minimum volume? Smallest frontal area? Lucas Ledex solenoids can pack more work per cubic inch than motors.

Lucas Ledex solenoid configurations

- Rotary —High torque, compact.
- Magdon —Longest life rotary, no axial movement.
- Linear —Short, medium, long stroke types. Push or pull.
- Open Frame—High performance at least cost.

5

Controllable characteristics

Look at the variety of parameters and characteristics the designer can optimize: ■ Force ■ Speed ■ Life ■ Acceleration ■ Quality ■ Noise ■ Repeatability ■ Reliability. Design flexibility also comes by using controls, such as: ■ Current limiting ■ Pulse (A to D) ■ Position sensing ■ Packaged switches. Call on us to discuss your application. Often just a phone call will start a shelf-stocked solenoid on its way.

Want to know more?

Request catalogs.

1-800-999-0009

for nearest sales office

Lucas Ledex Inc.

P.O. Box 427

Vandalia, Ohio 45377-0427 U.S.A.

Phone: 513-898-3621

Lucas Ledex

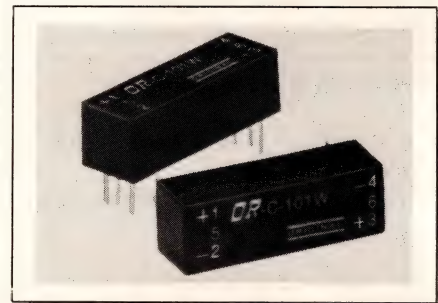
helpful motion control technology

COMPONENTS & POWER SUPPLIES

μsec. The relay will block the short-circuit condition indefinitely until the short circuit is removed and the input control is recycled. The relay is rated for a 2.1A/60V continuous load and features a 280-mΩ on-resistance. The status line is TTL compatible. The M85C-2AS meets the 28V dc MIL-STD-704 surge and spike requirements and is housed in a hermetically sealed, militarized DIP. \$90 (100).

Teledyne Solid State, 12525 Daphne Ave, Hawthorne, CA 90250. Phone (213) 777-0077.

Circle No 373



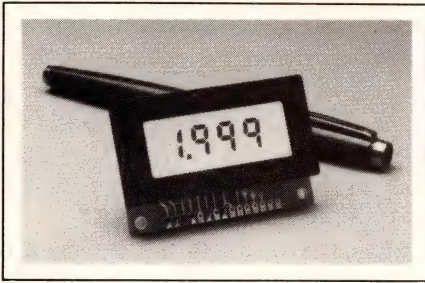
REED RELAY

- Designed to meet high-density packaging requirements
- Features a -30 to +60°C operating range

Measuring only 0.394×0.375×1.157 in. for a 1 Form A type, the OR-C Series reed relays meet the high-density packaging requirements of applications in instrumentation, audio and telecommunications equipment, and security and control systems. Contact configurations of 1B, 2A, 2B, 3A, and 3B are also available. The relays are available in both open and enclosed versions and operate over a -30 to +60°C range. Switching capability specs at 1A at 3 to 24V dc. Coil sensitivity ranges from 100 to 280 mW. The relays have a 2-million-operations lifetime at the rated load. \$1.36 (1000) for 1 Form A relays.

Original Electric Mfg Co Inc, 123 Lincoln Blvd, Middlesex, NJ 08846. Phone (201) 271-5770.

Circle No 374



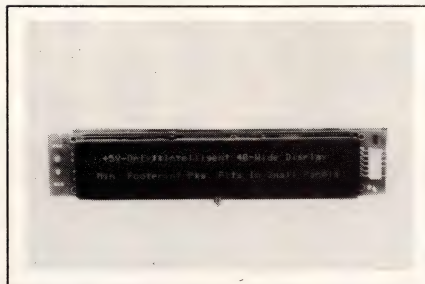
DIGITAL PANEL METER

- Supports all 4- to 20-mA transmitters
- Adjustable for both the zero and full-range spans

The DP-670 supports all 4- to 20-mA transmitters and interfaces directly to any 4- to 20-mA process loop. The meter draws operating power from the loop. The DP-670 features full differential input, 86-dB min CMR, and a dual-slope integrating A/D converter. As shipped from the factory, it is calibrated for a reading of 0 at 4 mA and 2000 at 20 mA. Both the zero and full-range spans are adjustable to permit users to fine tune the full-scale display ranges. You can momentarily freeze the display by strapping the hold-display pin to 5V dc. \$95.

Acculex, 440 Myles Standish Blvd, Taunton, MA 02780. Phone (617) 880-3660. TLX 503989.

Circle No 375



DISPLAY

- Flicker-free operation under data-loading conditions
- Onboard μP controls all display functions

The 3601-54-080 intelligent vacuum-fluorescent display provides two lines of 40 5×7 dot-matrix characters measuring 5.05 mm high. It

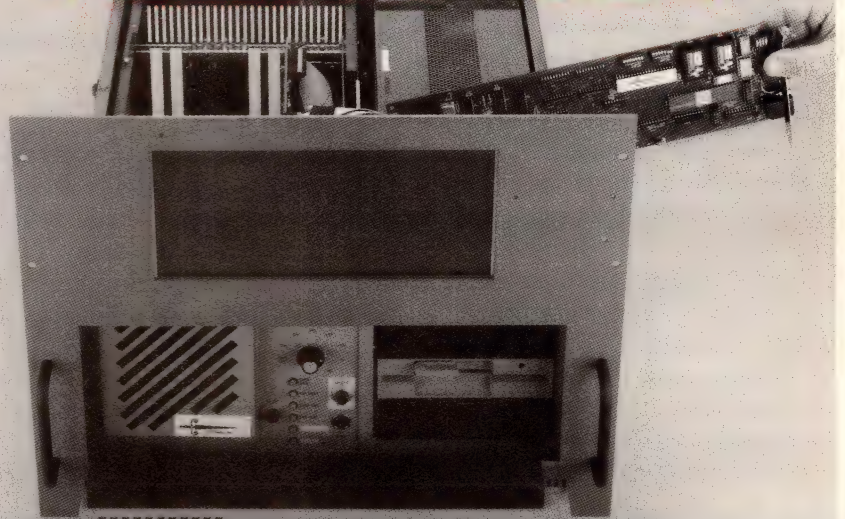
offers flicker-free operation under all normal data-loading conditions. An onboard μP controls all the display functions and easily interfaces to an 8-bit parallel TTL data bus. The module displays the full 96-character ASCII font and additional European characters, scientific symbols, and user-programmable characters. The brightness level is

typically 165 fL; software-control allows you to dim the display to approximately 50 fL. The display operates from a single 5V supply. From \$177 (100). Delivery, four to six weeks ARO.

IEE Inc, 7740 Lemona Ave, Van Nuys, CA 91409. Phone (818) 787-0311. TLX 4720556.

Circle No 376

MIL-STD-1553 ARINC-429

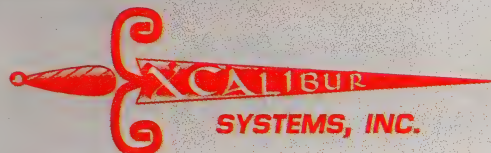


PLUG THEM INTO YOUR COMPUTER OR OURS.*

PRODUCTS INCLUDE: MIL-STD-1553, ARINC-429, INTELLIGENT RS-422 AND OTHER INTERFACE CARDS FOR IBM® PC/XT/AT® COMPATIBLE COMPUTERS.

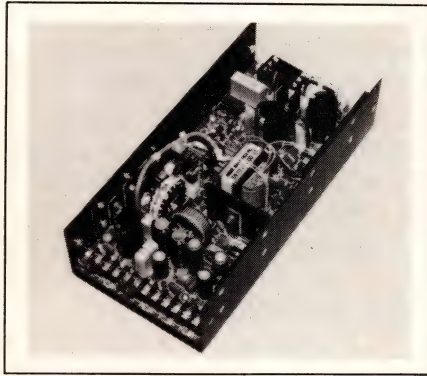
COMING SOON: COMPATIBILITY WITH APPLE COMPUTERS, INC.® AND IBM'S NEW SERIES COMPUTERS.

*EXCALIBUR SYSTEMS MODEL #EXC-ATC 19" RUGGEDIZED AT-COMPATIBLE COMPUTER.



P.O. BOX 6839, FRESH MEADOWS, NEW YORK 11365
(718) 575-3779 • (718) 358-8856 • TLX 6503473609(MCIUW)

CIRCLE NO 148



POWER SUPPLIES

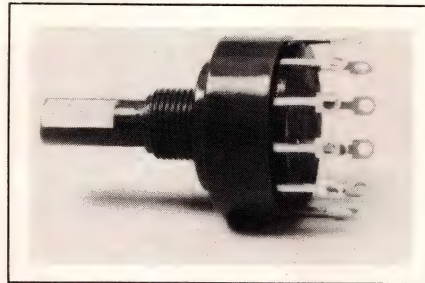
- Provide four fully isolated outputs
- Suitable for tight-space applications

Having dimensions of 5×2.5×10.5-in., NQF-200 Series 200W switch-mode power supplies are suitable for enclosures where space is at a premium. The units provide four fully isolated outputs. The main output is preset to 5V at 25A and features a remote-sensing capability. Users can specify the three auxiliary voltages in any combination. Standard values are 5, 12, 15, or 24V, but custom voltages are also available. Outputs 1, 3, and 4 are fully regulated. Output 2 is semiregulated and features a 10A surge-current rating. All outputs are fully protected against overload and short-circuit conditions. The supplies are

designed to meet VDE, UL, CSA, IEC, BS, and FCC safety standards and contain VDE-standard RFI line filters. \$252 (50).

Intelligence Power Technology Inc., 2111 Howell Ave, Anaheim, CA 92806. Phone (714) 937-1301. TWX 910-591-1893.

Circle No 377



ROTARY SWITCHES

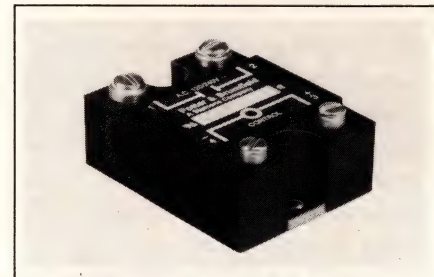
- Molded silver-plated terminals lock out flux
- Will carry 5A

Series 900A rotary switches are available in single-deck designs with 1- through 4-pole switching configurations. Standard features include a detent mechanism for a positive feel; insert-molded, silver-plated terminals for strength and flux lock-out; water-resistant housing-to-deck construction; 30° indexing; and an adjustable 2-through 12-stop position selector.

The units will switch 1A at 125V ac resistive and will carry 5A. Optional features include a choice of either solder-lug- or pc-board-type terminals, fixed stops, and a variety of bushing and shaft lengths and plating materials. \$0.90 (1000). Delivery, four to six weeks ARO.

Electroswitch Southern Operations, 2510 North Blvd, Raleigh, NC 27604. Phone (919) 833-0707. FAX 919-833-8016.

Circle No 378

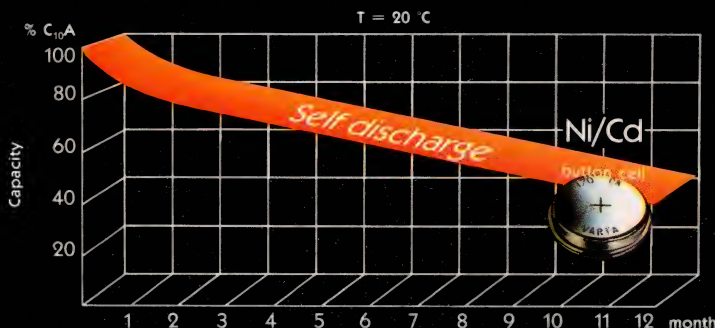


RELAYS

- Available in 10 and 25A versions
- Feature 4000V rms isolation

SSRT Series solid-state relays feature anspst NO contact configuration and are available in 10 and 25A versions for loads on 120 and 240V ac lines. Housed in the traditional hockey-puck package, they use a triac for the output device. A dv/dt

Use VARTA Ni-Cd batteries, and have 40% capacity left after 1 year's storage



The self-discharge curve demonstrates: Rechargeable VARTA button cells with mass-electrodes retain 40% capacity after 1 year and even 20% after 1½ year's storage. Sintered round cells typically lose up to 60% of their capacity after 2 months' storage.

Also you get Excellent Price/Performance Ratio, Dimensions, Rugged Construction, High Charging Efficiency and Good Load Performance.

Using VARTA Ni-Cd button cells gives you the benefits of superior energy, better design and lower costs for your product.

Order your test-samples now!

CIRCLE NO 149



VARTA

VARTA Batterie AG · Am Leineufer 51 · D-3000 Hannover 21 · W.-Germany
VARTA Batteries Inc. · 300 Executive Boulevard · Elmsford · N.Y. 10523-1202 · USA
VARTA Batteries Pte. Ltd. · P.O.Box 55 · Bedok North Post Office · Singapore 9146

The world's largest battery only manufacturer

TEAMWORK: THE POWER BEHIND WINNING PRODUCTS.



© MCMLXXXVIII Phillips 66 Company

When you are designing successful new products using plastics, you want winners on your team. Winners like Phillips 66.

Phillips 66 can be a powerful team member that provides quality products and expert application support. Our Phillips Research Center is renowned for developing a broad line of outstanding plastics. Plus the Phillips 66 Plastics Technical Center can help you integrate new materials into your business—with support that includes testing of materials, computer aided design, mold modification, process recommendations, and more. To make Phillips 66 a part of your winning team, call **1-800-53-RESIN**.

Turn the page to discover more about another new product from Phillips 66.

**PLASTICS WITH
POWER TO WIN™**



snubber network on the output protects against false triggering by restricting voltage-transient rise times. The zero-voltage-turn-on units are available with control voltage ranges of 3 to 32V dc or 90 to 280V ac. The relays employ optical coupling to develop 4000V rms input-to-output isolation. The relays are UL-recognized and CSA-certified. From \$15. Delivery, stock to 10 weeks ARO.

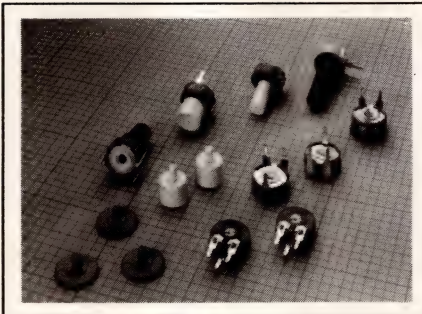
Potter & Brumfield Inc., 200 S Richland Creek Dr, Princeton, IN 47671. Phone (812) 386-2194.

Circle No 379

TRIMMERS

- Incorporate carbon-ink or cermet tracks
- Available with a variety of adjustment arrangements

The CP10 Series trimming potentiometers are available with either

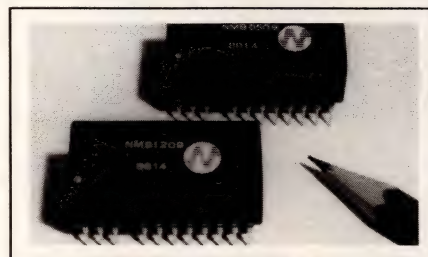


carbon-ink or cermet tracks. The carbon-ink versions use a Mylar film substrate that achieves a better humidity characteristic than conventional paper-phenolic materials. They are available with nominal resistance values between 100Ω and 10 MΩ, and have an end resistance of less than 3% of their nominal value. The cermet versions have a 0.5W power rating at 40°C, and a temperature coefficient of 100 ppm/°C. The nominal value tolerance is 20%, but tighter tolerance parts are available on special order. You can order versions with top,

side, or underside adjustment controls. From £0.06 (1000).

Bicc-Citec Ltd., Westmead, Swindon, Wiltshire SN5 7YT, UK. Phone (0793) 487301. TLX 449112.

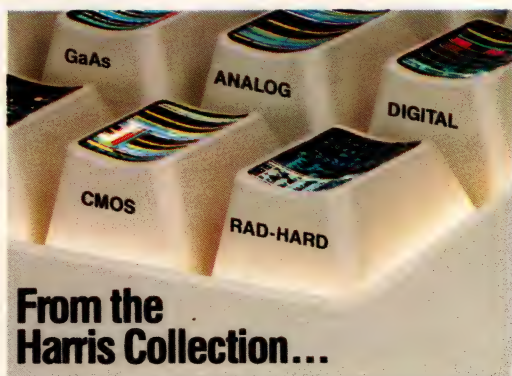
Circle No 380



DC/DC CONVERTERS

- Generate -9V from 5 or 12V dc inputs
- Suitable for use with Cheapernet transceivers

Producing a -9V/250-mA output from a 5 or 12V dc input respectively, the NMB0509 and NMB1209 pc-board mounting dc/dc converters



From the Harris Collection...

One source, one workstation for all ASIC military/space designs

You remember what semicustom used to be: all that time and money with no assurance your ICs would withstand hi-rel environments. Now Harris gives ASICs a change for the better. With advanced cell libraries...an open-system CAE/CAD toolset...integration with industry standard workstations (Daisy, Mentor, Sun and other UNIX-based platforms).

You do the front-end. Trust the back-end — masks, manufacturing, screening, packaging — to us. For the assured ASIC performance you're looking for, look to us! In U.S. phone 1-800-4-HARRIS, Ext. 1940. In Canada: 1-800-344-2444, Ext. 1940.



HARRIS

CIRCLE NO 252

©1988, Harris Corporation



From the Harris Collection...

Commemorating over 20 years of rad-hard IC service

First Minuteman, Polaris, Poseidon. Later MK-21, Trident I, Trident II, MX. Now MILSTAR and GPS. Soon SDI. Where has more than two decades of meeting your highest-performance needs left us? The leading rad-hard IC supplier to the military! Your job's not finished; neither is ours. In silicon or in gallium arsenide, we'll be there. We're there now. Call. In U.S. phone 1-800-4-HARRIS, Ext. 1935. In Canada: 1-800-344-2444, Ext. 1935.



HARRIS

CIRCLE NO 253

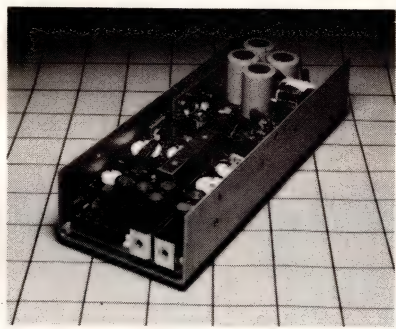
©1988, Harris Corporation

COMPONENTS & POWER SUPPLIES

are designed for use in LAN equipment that conforms to the Ethernet or Cheapernet specification. They are suitable for use with a variety of transceiver chip sets. The converters have an input-to-output isolation of 500V dc, and an operating efficiency as high as 80%. They do not require additional heatsinking or derating over their operating temperature range of 0 to 70°C. The converters are housed in 24-pin DIPs with a height above the pc board of 10.8 mm. Around £8 (1000).

Newport Components Ltd, Tanners Dr, Blakelands North, Milton Keynes MK14 5NA, UK. Phone (0908) 615232. TLX 825621.

Circle No 381



POWER SUPPLY

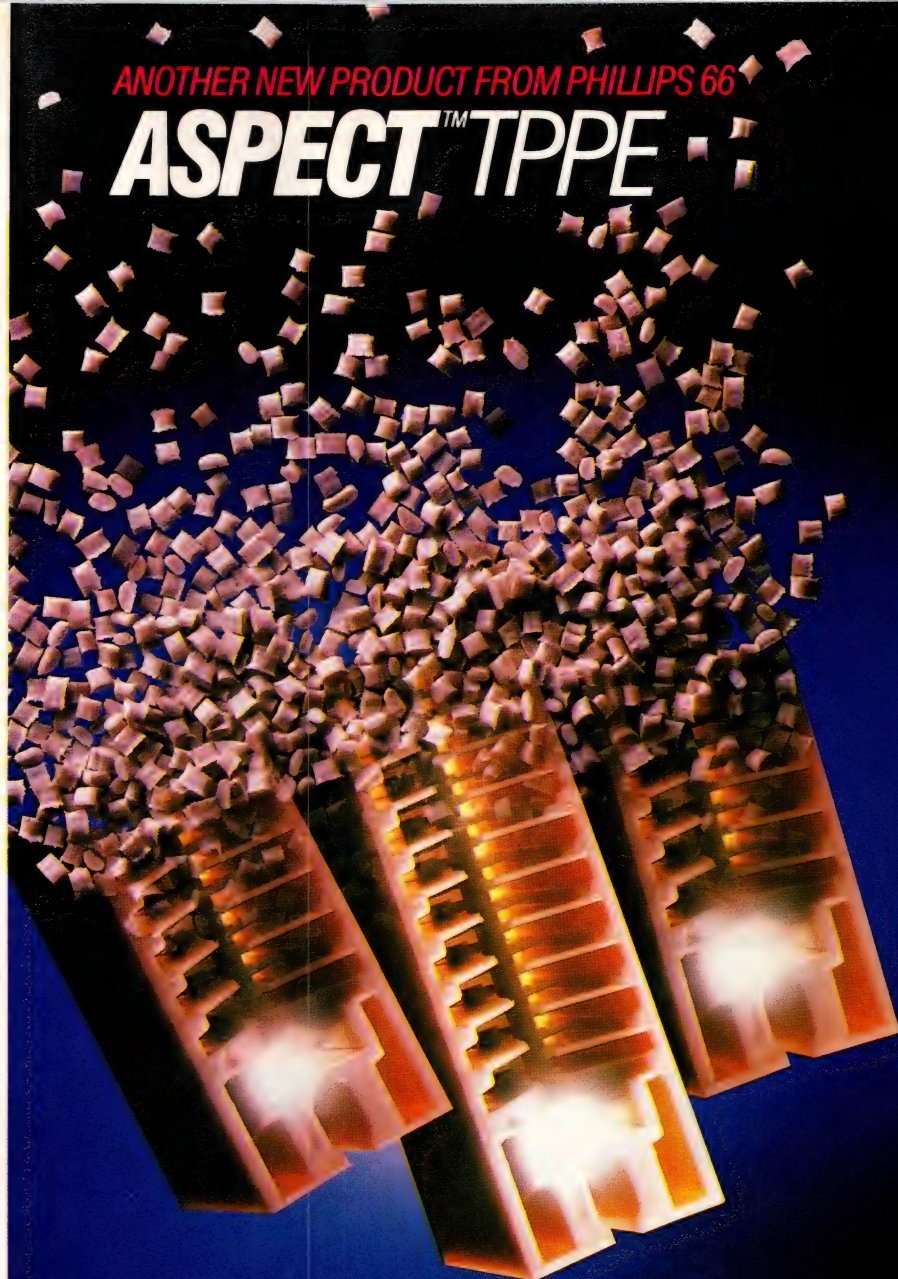
- Delivers 700W
- All outputs are user-adjustable

The MAX-704 delivers 700W and provides 100A at 5V for logic and memory applications. As many as three auxiliary outputs provide regulated 12 or -5.2V at 20A max. All outputs feature a $\pm 5\%$ user-adjustment range. Overload protection is provided on all outputs as is over-voltage protection on the 5V main output. Remote inhibit is standard, and power-fail is available as an option. MTBF specs at 80,000 hours. The supply meets international safety requirements such as UL 478, CSA 22.2, IEC 380 and 435, and the Class A RFI standards of FCC and VDE 0871. The supply features creepage and clearance distances of 4 and 8 mm, respectively,

EDN August 18, 1988

ANOTHER NEW PRODUCT FROM PHILLIPS 66

ASPECT™ TPPE



© MCMLXXXVIII Phillips 66 Company

ASPECT™ TPPE from Phillips 66 can bring a new dimension to your electronic components: a thermoplastic polyester with outstanding processability, excellent toughness, and superior long-term thermal aging. Consider the cost-efficiency and results you can achieve with excellent flow properties, low molding pressure and high temperature performance.

Phillips 66 ASPECT™ TPPE is available in both natural and flame-retarded grades with two levels of glass reinforcement. It is the first in a line of Application Specific Thermoplastics from Phillips 66 that can meet your unique requirements. For more information about ASPECT™ TPPE and the full line of Phillips 66 Plastics, call 1-800-53-RESIN.



ASPECT™ TPPE
PLASTICS WITH POWER TO WIN.™

CIRCLE NO 152

COMPONENTS & POWER SUPPLIES

to meet SELV requirements. \$549 (100). Delivery, stock to six weeks ARO.

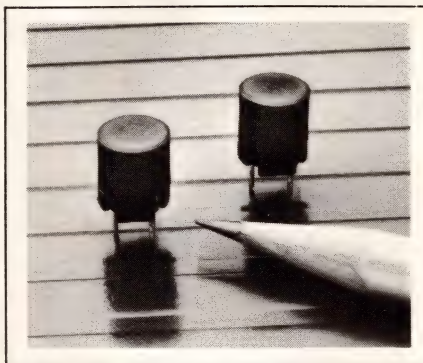
Todd Products Corp., 50 Emjay Blvd, Brentwood, NY 11717. Phone (516) 231-3366. TWX 510-227-4905.

Circle No 382

INDUCTORS

- *Internal capacitor conserves pc-board space*
- *Can accommodate wave-soldering processes*

Model 8RBC fixed inductors are designed for noise-filtering and trapping applications. They feature an internal matched capacitor that provides a stable temperature coefficient, conserves pc-board space, and reduces design and assembly time. Inductance values range from 1 to 45 mH, and the operating frequency range spans 50 to 200 kHz. Values for the internal capacitor range



from 5 to 6800 pF. The inductor base features pedestals that protect the winding terminations during assembly operations. The base is molded from UL 94V-1-grade phenol for heat protection during wave-soldering processes. All terminals are presoldered to provide reliable pc-board bonds. \$1. Delivery, six to eight weeks ARO.

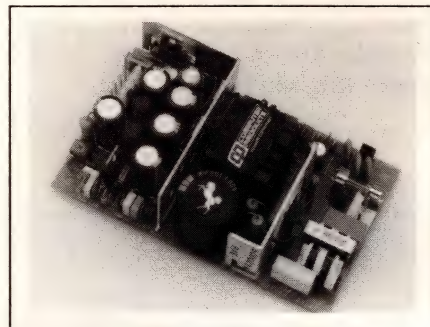
Toko America Inc., 1250 Feehanville Dr, Mount Prospect, IL 60056. Phone (312) 297-0070.

Circle No 383

POWER SUPPLIES

- *Accept any input from 85 to 264V ac without jumpers*
- *Available in single- and triple-output versions*

NFS40 40W switching power supplies will accept any input from 85 to 264V ac without the need for jumper wires or a switch. Versions are available with single outputs (5, 12, 15, or 24V) and triple outputs (various combinations of 5, 12 and 15V). The supplies will regulate down to zero output load and feature a



VME Dream Card

The HK68/V30 is the card you've been dreaming of.

This fully-loaded single-board VME microcomputer combines the highly sought-after qualities of high speed and advanced on-card functionality. Now you can have high-end performance for UNIX and real-time applications. Standard equipment:

- Up to 25 MHz Motorola 68030 CPU
- 4 or 16 MB of on-board DRAM with parity
- Up to 1 MB of EPROM
- 2 serial I/O ports
- Single 8-bit parallel port
- Mailbox interrupt support.

Optional equipment includes on-board 68881/68882 FPP, SCSI interface and Time-of-Day clock with battery back-up.

HEURIKON CORP.

Take Heurikon's HK68/V30 for a grand tour today.

Call toll-free: 800-356-9602 (ext. 503).

Telefax: 608-251-1076

3201 Latham Drive ■ Madison, WI 53713

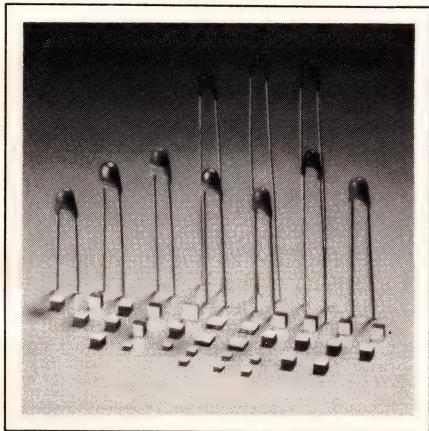
CIRCLE NO 153

COMPONENTS & POWER SUPPLIES

160,000-hour MTBF. Line regulation is $\pm 0.5\%$ max and efficiency specs at 70%. The supplies are approved by UL, CSA, and VDE, and provide sufficient line filtering to meet FCC limit B and VDE limit A line-conducted noise specs. Of the eight models making up the line, only the NFS40-7608 is stocked as a standard product. From \$59 (1000).

Computer Products Inc., 2900 Gateway Dr, Pompano Beach, FL 33069. Phone (305) 974-5500. TWX 510-956-3098.

Circle No 384



THERMISTORS

- Feature a 0.75% beta-value tolerance
- Provide low-thermal-conductivity leadouts

NTC thermistors in the 640-6 and 645-0 stable-line families have a 0.75% beta-value tolerance and a 25°C resistance (R25) with a 3% tolerance. These tolerances allow the units to achieve an accuracy of 1.5°C at 85°C. The 640-6 family comprises 16 devices with R25 values between 2.7 and 470 kΩ. The 645-0 family offers four devices with R25 values of between 5 and 10 kΩ and 38-mm low-thermal-conductivity nickel leads. The thermistors operate from -40 to +125°C. When operating at their maximum rated power of 250 mW, the units function over a reduced range of 0 to +55°C. Gld 0.38 (10,000) for thermistors

SPEECH

For over seven years the Echo™ speech output products from Street Electronics have set the standard for reasonably priced voice equipment.

There are now two new Echo speech boards for MS DOS®-based machines:

the Echo MC for the IBM Personal System/2 Micro Channel™ products, and the ECHO

PC+ for the IBM PC and compatibles. These products utilize the new Echo speech chip which processes digitized voice;

natural sounding LPC voice, and unlimited

vocabulary text-to-speech.

OEM quantity pricing for all these products is under \$100.

The Street CMOS speech processing chip, custom LPC vocabulary generation, and technology licensing are also available.

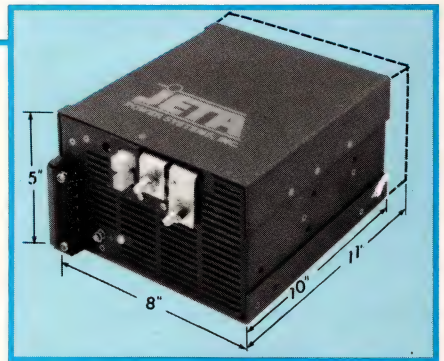


Street Electronics Corporation

6420 Via Real, Carpinteria, CA 93013 (805) 684-4593

CIRCLE NO 154

We'll give you
an inch...
and
**1200
WATTS**



Where other manufacturers require 11" or more in a 1200 watt design, JETA gives you the same output power ratings *plus* an extra inch. So you can fit even more into your CAD/CAM/CAE systems, mini-main frames or communications products.

For compact high-current single and multiple output power supplies from 500 to 2200 watts, contact JETA.

See EEM pages D1706-1708



POWER SYSTEMS, INC.

2675 Junipero Avenue ■ Signal Hill, CA 90806
Tel: 213/427-0095 ■ TWX: 510-101-1804 ■ FAX: 2134262417

CIRCLE NO 155

NEW! SWITCHMODE POWER SUPPLIES FROM STOCK

- 2 to 48 VDC Outputs
- Automatic Current Sharing On All Outputs
- N+1 Capabilities



MULTIPLE OUTPUT



- 350 to 1500 Watts
- 3 to 15 Outputs

SINGLE OUTPUT



- 400 to 3000 Watts in 5" x 8" Standard Package
- 155,000 Hrs. Demonstrated MTBF

Hot Plug-In FAULT TOLERANT (N+1) POWER SYSTEMS



- Two to Six Supplies
- Expandable, 300 to 1800 Watts
- Internal Isolation Diodes (Option)

Powertec

A Bonar Power Supplies Company
20550 Nordhoff Street Chatsworth, CA 91311
(818) 882-0004 • FAX (818) 998-4225

CIRCLE NO 156

COMPONENTS & POWER SUPPLIES

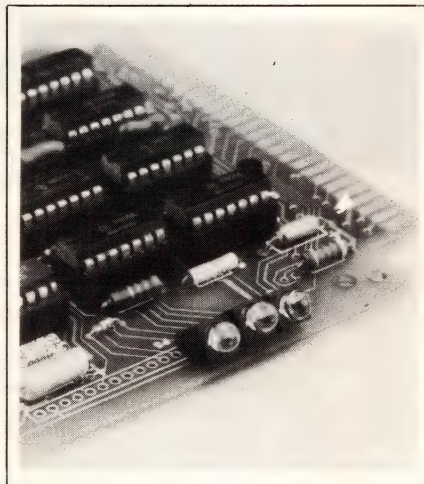
with a 5% R25 tolerance.

Philips, Components Division,
Box 523, 5600 AM Eindhoven, Netherlands. Phone (040) 757189. TLX 51573.

Circle No 385

Mepco/Centralab Inc, Box 760,
Mineral Wells, TX 76067. Phone
(817) 325-7871.

Circle No 386



INDICATORS

- Mount at a 45° angle for better visibility
- Meet UL94V-0 requirements

PC45 Series LED indicators mount on pc boards with the LED at a 45° angle. This design makes the devices well-suited for applications requiring viewing from an elevated position. Designed for use on the edge of boards positioned low in a cabinet or rack, the LEDs are compatible with side-by-side or front-to-back mounting. The indicator housings meet UL94V-0 flammability requirements and are available in red, green, amber, and yellow, all with a choice of diffused or nondiffused encapsulation. Typical operating current and voltage drop spec at 20 mA and 2.1V, respectively. From \$0.22 (1000). Delivery, stock to six weeks ARO.

Data Display Products, Box 91072, Los Angeles, CA 90009. Phone (800) 421-6815; in CA, (213) 640-0442.

Circle No 387



HV SUPPLY

- Powers high-resolution CRTs
- Features full regulation

You can employ the 836A shadow-mask supply for high-resolution monitors. The fully-stabilized dc/dc converter operates from a 20 to 30V input. The supply provides a 22 to 28 kV output voltage at currents as high as 1.2 mA for the final anode of the CRT; the adjustable output voltages for the CRT's focus and G2 grids; and a -200V output for the control grid. The standard model includes a floating, stabilized supply for the CRT's heater and a +400V output to power dynamic focusing circuitry. The ripple voltage on the anode output is less than 5V p-p. Static zero- to full-load output regulation on the anode output is 15V. Around £70 (1000).

Brandenburg Ltd, 939 London Rd, Thornton Heath, Surrey CR4 6JE, UK. Phone 01-689-0441. TLX 946149.

Circle No 388

Astec (USA) Ltd, 2880 San Thomas Expressway, Suite 200, Santa Clara, CA 95051. Phone (408) 748-1200. TLX 6839191.

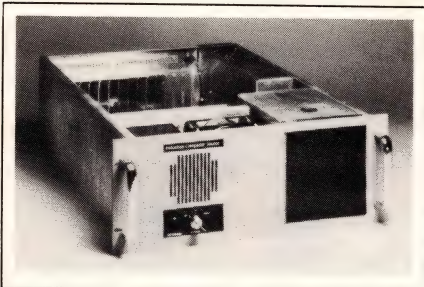
Circle No 389

CHASSIS

- Delivers full PC/AT functionality
- Includes a filtered cooling system

The 7515-24H chassis is designed for installation inside a standard 19-in. rack. When appropriately configured, the chassis can serve as a node, server, or gateway in a network. With its 15-slot backplane,

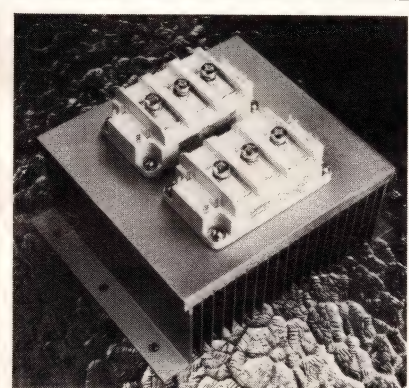
COMPONENTS & POWER SUPPLIES



the chassis delivers full PC/AT functionality. The rugged steel enclosure includes a disk-carrier assembly that can hold as many as four half-height drives, a drive-area cover door, a system reset button, and a 200W power supply with a filtered cooling system. A positive-pressure buildup inside the chassis prevents dust particles from damaging any installed drives. From \$1395.

Industrial Computer Source, 5466 Complex St, Suite 208, San Diego, CA 92123. Phone (619) 279-0084. FAX 619-541-1138.

Circle No 390



HEAT SINKS

- For natural-convection and forced-air applications
- Achieve 0.024 to 0.08°C/W thermal resistance

Series 6760 bonded-fin heat sinks are designed for both natural-convection and forced-air applications. Available in nine standard sizes, the heat sinks feature mounting-hole patterns that accept all standard-power-module packages. Forced-air models are designed to

More than just another pretty interface... *this keyboard is intelligent.*

If you're designing electronic instrumentation for medical, aerospace, military or industrial applications, a Foster designed Application-Specific User Interface Terminal (ASUIT™) can increase functionality, simplify design and lower your total costs.

Foster manufactures embossed, snap-action, tactile keyboards which can include second board systems (piggybacks) to interface with your host instrument, providing functions such as:

- keyboard encoding
- display and display control
- system controller functions

Eliminate multi-vendors and "over design" of your instrument. Foster Engineering offers complete product support, from engineering to production and testing for standard systems, custom systems, custom keyboards and graphics. Send for our Designer's Guide or call today.

Foster

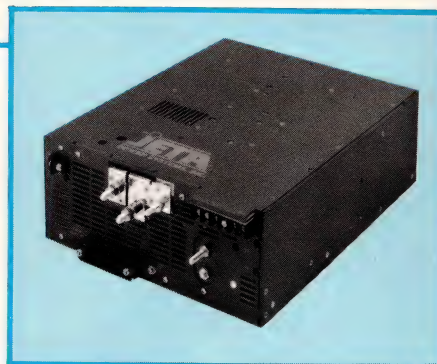
Engineering & Mfg., Inc.

1 West Lone Cactus Drive, Phoenix, Arizona 85027 (602) 492-0071



CIRCLE NO 157

with 5 outputs... to **2200** WATTS



Main output to 300A. Our 2200 watt, UL/CSA/VDE/IEC compliant, power supply offers 1 to 5 outputs. Standard features include DC OK, FCC EMI filter, power fail, remote inhibit, remote margining, electronic soft start and more—many of which would be costly options elsewhere.

High reliability is derived from a reduced component count, high-voltage transistor V-I load reshaping for maximum SOA and careful thermal management to ensure the best operating environment for critical components.

For reliable high-current single and multiple output power supplies from 500 to 2200 watts, contact JETA.

See EEM pages D1706-1708



POWER SYSTEMS, INC.

2675 Junipero Avenue ■ Signal Hill, CA 90806
Tel: 213/427-0095 ■ TWX: 510-101-1804 ■ FAX: 2134262417

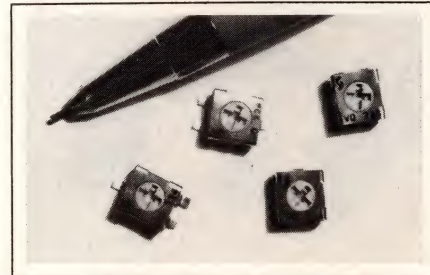
CIRCLE NO 158

accept standard muffin fans with a 4.12-in.-square mounting hole pattern. These models are 5.25 in. high and have mounting surfaces ranging from 7×4.78 to 16×10.78 in. Thermal resistance ranges from 0.024 to 0.08°C/W. Natural-convection models are 3.130 in. high and available in 7- and 12-in. lengths. These units have a 7.375-in.-wide mounting sur-

face and are available with or without mounting flanges. Thermal resistance ranges from 0.22 to 0.30°C/W. \$39.37 (100) for the 7-in. natural-convection model. Delivery, eight to 12 weeks ARO.

Aavid Engineering Inc., Box 400, Laconia, NH 03247. Phone (603) 528-3400.

Circle No 391



TRIMMERS

- Have a temperature coefficient of 50 ppm/°C
- Provide surface mounting

The TS5Y-series single-turn, miniature, surface-mounting trimmer potentiometers feature automatic and manual adjustment. A clutch mechanism prevents damage to the trimmers. For nominal values of 100Ω or higher, the trimmers feature a ±50 ppm/°C temperature coefficient. They come with nominal resistance values between 10Ω and 1 MΩ with either ±10% or ±20% tolerance. The trimmers have a power rating of 0.2W at 85°C and an operating temperature range of -55 to +155°C. Housed in a sealed package, the trimmers can withstand vapor-phase or reflow soldering, and water cleaning. \$0.20 (1000).

Sfernice, 199 blvd de la Madeleine, 06021 Nice Cedex, France. Phone 93446262. TLX 470261.

Circle No 392

Ohmtek, 2160 Liberty Drive, Niagara Falls, NY 14304. Phone (716) 283-4025. TWX 710-524-1653.

Circle No 393

CIRCUIT BREAKERS

- Address the problem of nuisance tripping
- Current ratings of 5 to 20A

To address nuisance tripping problems, S Series circuit breakers incorporate a solenoid. To reset a remote breaker, you simply actuate the solenoid. The solenoids will operate from 24V ac, 120V ac, or 24V dc. The devices are available in 250V ac and 50V dc versions with

NEW
from the
HANDLE SPECIALISTS

**POSITIVE
LOCKING
FOLDING
HANDLES**
PATENT PENDING

MEET
MIL-STD-1472C
REQUIREMENTS

Designed for military
applications where vibration
and sudden impact may occur

AMATOM ELECTRONIC HARDWARE

446 Blake St. New Haven, CT 06515 800/243-6032, in CT 203/397-3311

- Ideal for airborne and shipboard equipment.
- Heat treated 300 series stainless locking components.
- Easy, one hand operation • lightweight extruded aluminum.
- Heli-Coil® inserts for secure mounting. • Black anodized finish.
- Available from stock in six lengths & two heights.

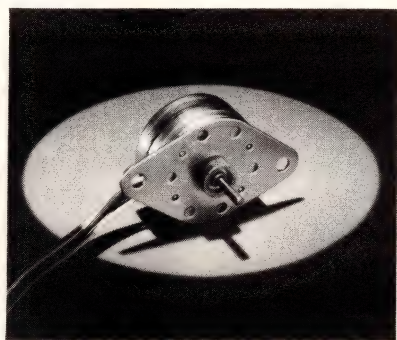
CIRCLE NO 254

COMPONENTS & POWER SUPPLIES

current ratings of 5, 10, 15, and 20A. At 200% of rating, tripping time is 6 to 30 sec. Acceptable solenoid-actuation techniques range from a simple switch to a radio-receiver signal. \$85 (10).

Casco/Maitland, Box 947, Roswell, GA 30077. Phone (404) 475-3192.

Circle No 394



STEPPER MOTORS

- Operate from either 5 or 12V dc supplies
- Suitable for portable equipment

With a housing that measures only 1-in. in diameter, Series M82100 and N82100 stepper motors are well suited for portable equipment where space is at a premium. The motors have step angles of 7.5 and 15°, respectively. Both operate from either 5 or 12V dc supplies and are available for unipolar or bipolar operation. The PM motors come equipped with permanently lubricated bronze sleeve bearings. Holding torques for unipolar or bipolar units spec at 1.3 and 1.5 oz-in. on 7.5° models, and 0.7 and 1.0 oz-in. on 15° models. M82100 motors have a 1.1×10^{-4} gm² rotor moment of inertia and a $\pm 0.5^\circ$ step-angle tolerance. These parameters equal 4.5×10^{-5} gm² and $\pm 1^\circ$, respectively, for N82100 motors. Bipolar motor, \$5.35 (500). Delivery, four to 12 weeks ARO.

Airpax Co., Box 868, Cheshire, CT 06410. Phone (203) 272-0301.

Circle No 395

the unlimited design benefits of miniature metal tubing.



design benefits number 107 and 108

PUNCHING/NOTCHING

Round, square, rectangular and elongated holes can be punched or notched in miniature tubing to tight tolerances. Single or multiple configurations are available depending upon tube diameter and wall thickness. Check the know-how, fabrication expertise and alloy selection at Uniform Tubes. Phone toll free 1-800/321-6285 or send for our design packed folder.



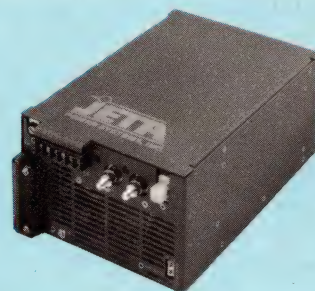
UNIFORM TUBES, INC.

Collegeville, PA 19426-0992 • Telephone: 215/539-0700
TWX: 510-660-6107 • Telex: 84-6428 • FAX: 215/489-1150
In Europe: UTI U.K. 983-404049 • Telex: 869441 UTIUK G

CIRCLE NO 264

...and we'll back
it up!

750 WATT
multiple output
battery backup
supply.



For safe and orderly system shutdown in the event of blackout or even brownout situations, choose our battery backup switching power system.

JETA's proven multiple output power supply technology combines with a dual-stage charger, boost converter and 48V battery to provide your system with unlimited holdup time (depending on battery capacity) in the event of AC line failure.

2-YEAR WARRANTY on all models

At JETA, we back up all our power supplies with a full two-year guarantee. After we beat them up and then burn them in, we're confident that you'll receive the finest high-current power supplies built.

For single and multiple output power supplies from 500 to 2200 watts, contact JETA. We back them up.

See EEM pages D1706-1708



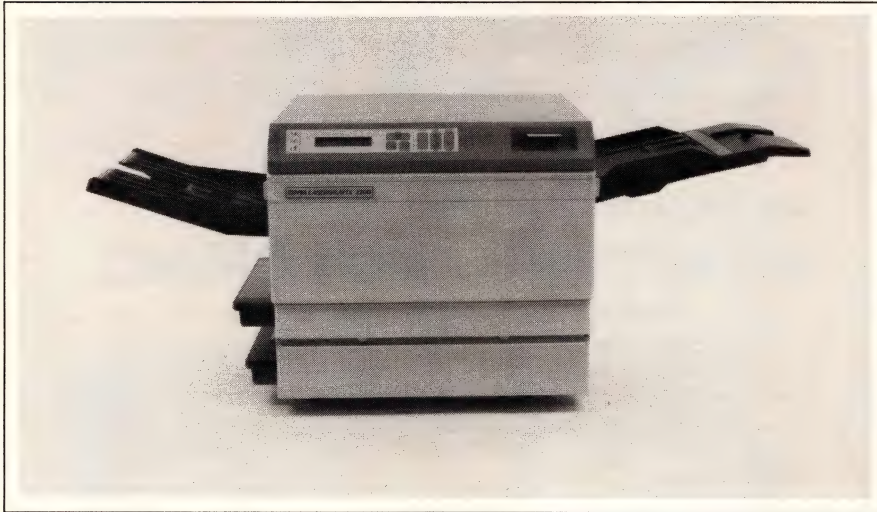
POWER SYSTEMS, INC.

2675 Junipero Avenue ■ Signal Hill, CA 90806
Tel: 213/427-0095 ■ TWX: 510-101-1804 ■ FAX: 213/4262417

CIRCLE NO 177

NEW PRODUCTS

COMPUTERS & PERIPHERALS



LASER PRINTER

- Prints 22 pages/minute
- Offers 36 resident fonts

The Lasergrafix 2200 laser printer prints at 22 pages/minute and can handle 11×17-in. paper. It offers 36 resident fonts and can support optional slim-card font cartridges. Using an HP-GL emulator, you can make B-size CAD drawings. The desktop printer has two 250-sheet letter-size paper cassettes and one 100-sheet ledger/letter paper cassette. The print engine includes a 16-MHz 68000 μ P and 7M bytes of

RAM. The engine can concurrently process two B-size pages of bit-mapped graphics at a 300×300-dot/in. resolution. An optional QMS 80-VE interface connects to a Versatec parallel interface on a CAD workstation to emulate the Versatec V-80 electrostatic printer. Another optional printer interface lets the printer attach to IBM 3276, 3274, or 3174 controllers for printing on the IBM 3270 network. \$14,995.

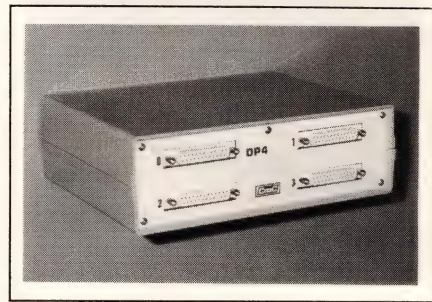
QMS Inc., 1 Magnum Pass, Mobile, AL 36618. Phone (205) 633-4300.

Circle No 351

sample adapter-description files. An acquisition engine provides high-level programming commands for data acquisition and I/O control. Kits range from \$495 to \$995.

Capital Equipment Corp., 99 S Bedford St, Burlington, MA 01803. Phone (617) 273-1818.

Circle No 352



MULTIPLEXER

- Adds four buffered ports to any RS-232C or RS-422 port
- Transmit and receive buffers

The DP4 is a 4-port multiplexer for RS-232C or RS-422 interfaces. Each of the four ports contains a 4992-byte transmit data buffer and a 4992-byte receive data buffer. The unit lets the user simultaneously communicate with as many as four devices operating at the same or different baud rates from 75 to 38.4k baud. You can individually select the baud rates, parity, and word length. The unit supports XON/XOFF and hardware handshaking techniques. It is one of the company's CMCNet II system products and can create a system that supports as many as 6400 users via multidrop. Menu-driven control software for IBM PCs and compatible computers is included free of charge. \$695.

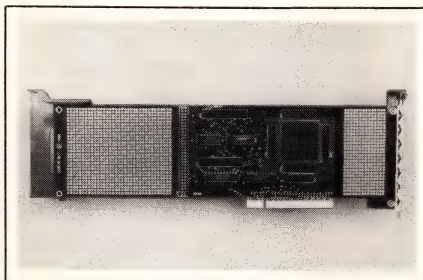
Connecticut MicroComputer Inc., Box 186, Brookfield, CT 06804. Phone (203) 354-9395. TWX 710-456-0052.

Circle No 353

PROTOTYPE BOARD

- For the Micro Channel in IBM's PS/2 model 70 computer
- Features the One Chip Plus interface chip

The One Chip Plus add-in prototype development board for the IBM PS/2 model 70 computer features the company's 88C01 interface chip for the Micro Channel. You can program the chip to decode addresses for extended memory, expanded memory, ROM, and multiple I/O ports. It also supports the Micro Channel DMA arbitration and burst-mode DMA. The chip sup-



ports all speeds of the model 70: 16, 20, and 25 MHz. The hardware kit includes the board with decoded memory and an interface for connecting a logic analyzer. The software kit includes the extended and expanded memory driver (LIM 4.0 specification), design utilities, and

68030 - VME The Real *Single* Board Computer The TP32V from Tadpole

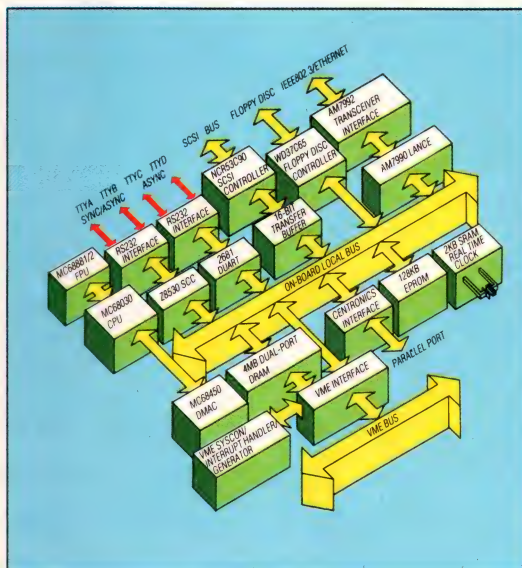
• The Philosophy •

Designed for optimum system performance from a single full IEE 1014 VME board, the TP32V needs no other cards, piggy-backs or mezzanines to deliver the full potential of the 16-33 MHz MC68030. To maximise overall throughput, all the on-board I/O facilities were designed to take advantage of hardware transfer buffers, DMA facilities and advanced DRAM arbitration techniques between competing resources.

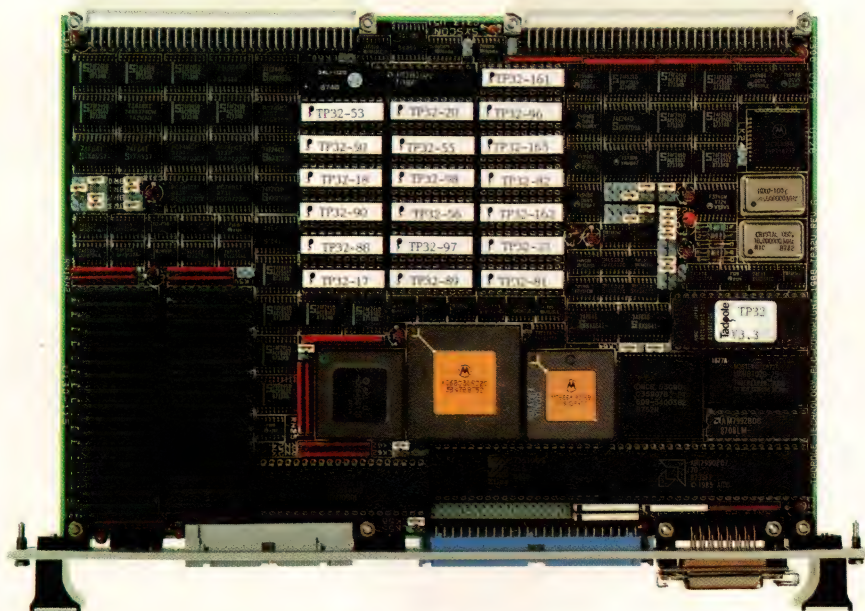
- The Specification •

- MC68030 16-33MHz
- MC68450 4-channel DMA controller
- 4Mb multi-ported nibble-mode DRAM
- AMD Lance IEEE 802.3 Ethernet with DMA
- Z8530 SCC giving two DMA-driven RS232 sync/asynchronous ports and two further RS232 asynchronous ports
- NCR 53C90 DMA-driven synchronous or asynchronous SCSI interface
- Floppy disk controller
- Full VME Rev C.1 IEEE 1014 interface
- 64-512Kb EPROM
- Battery-backed RTC/SRAM
- Full debug monitor
- Optional MC68881/2 FPU
- TP-IX/68K version of UNIX V.3.1*
- NFS, NFS, TCP/IP

• The Design •



• The Evidence •



Tadpole Technology
the driving force in 32-bit design

Tadpole Technology plc

Titan House, Castle Park,
Cambridge, CB3 0AY, UK.
Tel: 0223 461000
Fax: 0223 460727

Tadpole Technology Inc

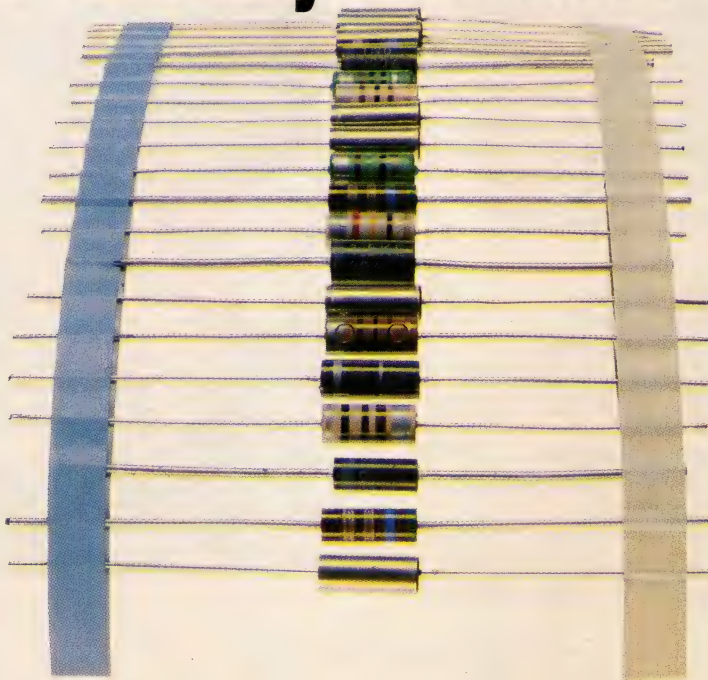
Reservoir Place,
1601 Trapelo Road, Waltham,
Massachusetts 02154, U.S.A.
Tel: 0101-617-890-8898
Fax: 0101-617-890-7573

2157 O'Toole Avenue,
Suite F, San Jose,
California 95131, U.S.A.
Tel: 0101-408-435-8223
Fax: 0101-408-435-8432

T A D P O L E

UNIX is a trademark of AT&T Ethernet is a trademark of the Xerox Corporation
VRTX is a trademark of Ready Systems *TP-IX V.3.1 is derived from UNIX V.3.1

Now your CMOS backup battery can be what you've always wanted it to be.



Just another component.

Forget those labor intensive methods normally required for printed circuit board mounting of batteries. Our new axial lead μ PowerCells™ (Lithium Iodine 2.8V Solid CMOS Backup Cells) look like a resistor or capacitor. They're about the same size and they don't need special handling. You can put them on a sequenced tape reel for automatic printed circuit board insertion. And like most other components, μ PowerCells™ can be wave soldered, cleaned and dried using

normal procedures.

Once they're in place, μ PowerCells™ are dependable. Their Lithium Iodine chemistry is the number one choice for powering cardiac pacemakers. And a performance study of over 1 million batteries in use shows that a useful life of more than 20 years can be predicted.

At 35 milliamp-hours, the axial lead μ PowerCell™ will handle most CMOS backup problems. However, higher capacity versions to 1 amp hour are

available in a new space-saving rectilinear package. The Catalyst Research line includes modules for sensing power loss and transferring to battery backup as well as clock modules with battery built in.

Best of all, Catalyst Research μ PowerCells™ are priced like other components.



ACTUAL SIZE

For more information, call us at 301-296-7000 ext. 304.

CATALYST RESEARCH
A DIVISION OF MINE SAFETY APPLIANCES COMPANY

1421 Clarkview Road Baltimore, MD 21209-9987, USA Telephone (301) 296-7000 ext 304 Telex 898095 CATALYST

WORKSTATIONS

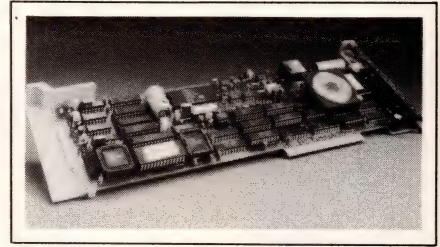
- Six models for the VAXstation 2000 family
- Feature an 8-bit plane graphics coprocessor

The VAXstation 2000 family has six new models of desktop workstations. They incorporate the company's MicroVAX II CPU and floating-point unit along with a choice of a 15- or 19-in. color monitor. A graphics coprocessor module supports 8-bit planes and offers 256 simultaneous colors from a palette of 16M colors. A 12M-byte memory-expansion module provides a total of 14M bytes of memory. The models are available with either a VMS or an Ultrix operating system. Optional main storage comes in 42M-, 71M-, or 159M-byte hard disks. Backup options include a 96M-byte streaming tape and a 1.2M-byte floppy-disk drive. Applications developed for the VAXstation II/GPX,

3200, and 3500 workstations are fully compatible with the new systems. A system with an 8-bit plane coprocessor, 6M bytes of memory, and a 15-in. color monitor costs \$13,830.

Digital Equipment Corp., 146 Main St., Maynard, MA 01754. Phone (617) 493-4297.

Circle No 354



MODEM CARD

- Allows microcomputer-to-main-frame communication
- Includes autodial and autoanswer facilities

The Syncro-24-PS add-in synchronous modem for IBM-PS/2 computers or Micro Channel Architecture systems lets these systems access mainframe computers. The modem transmits at 2400 bps. It complies with CCITT V26-bis specifications. Another version, the Syncro-48-PS,

operates at 4800 bps. This version conforms to V27-ter specifications. The modem's software indicates the condition of the modem-interface signals. Along with the modem's onboard speaker, the software provides information on call progress. In addition, the software provides autodial and autoanswer facilities using commands based on the AT and CCITT V25-bis standards. You can use the autodial software with synchronous communication packages that don't feature autodial functions. You enter dial commands via an independent control channel, which lets you monitor the call's status. A nonvolatile RAM stores



spectron

Gravity
Referenced

Measures:
Slope, Tilt
Angle, Pitch

37 Years Experience

Electrolytic Tilt SENSORS

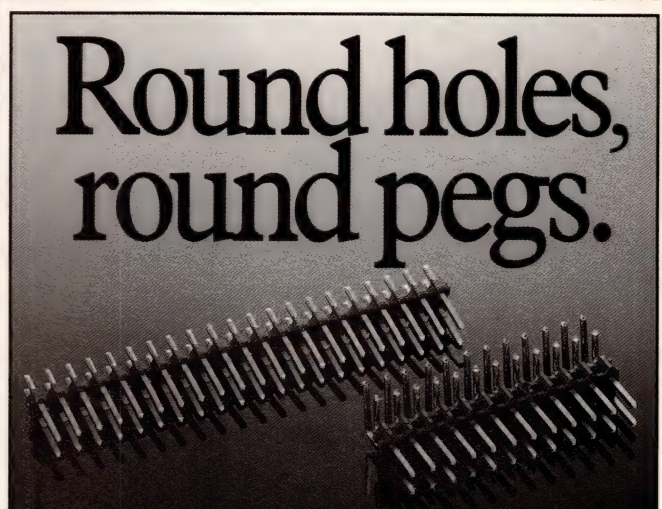
Features

- Small, compact, easily mounted. Rugged in hostile environments. Single or double axis. Low cost.
- Excellent repeatability and stability. Ranges to 120°.
- Resolutions to <1 arc second.

Electrolytic gravity sensors offer an excellent solution to systems that require a gravity reference or tilt indication. These transducers will meet your specs for the most difficult applications. Write or call for our catalogue.

SPECTRON
Glass and Electronics Inc.
595 Old Willets Path
P.O. Box 13368
HAUPPAUGE, N.Y. 11788
516-582-5600, Fax 516-582-5671

Round holes, round pegs.



Now there's a PC board header that doesn't ask you to fit square pins into round holes. It's the VIK-STIX™ and it features 0.25 in. square mating posts on .100 in. centers. The round PC tail improves soldering action. So do the standoffs. They allow flux to be cleaned from under the header. Selective plating puts gold just where you need it - on the contact area. The glass-filled polyester insulator won't absorb moisture and warp. And an innovative VIK-CLIP holds the header firmly to the board during wave soldering. A simple break-away design reduces inventory costs.

VIK-STIX is available in single and dual row, straight and right-angle configurations. Call or write today for full details.

CRITON VIKING

VIK-STIX™

21001 Nordhoff St., Chatsworth, CA 91311 • (818) 341-4330

CIRCLE NO 162

CONFIGURE-YOUR-OWN
MIL SPEC • HIGH RELIABILITY
POWER SUPPLIES



A HIGHER LEVEL OF PERFORMANCE

INTRODUCING EL 2000 SERIES

Complete AC to DC and DC to DC multi output systems.

MORE BENEFITS

Save Space: Completely protected AC-DC systems with rugged high density packaging to 8 watts/in³.

Less Heat: Efficiencies to over 80% with next generation circuitry.

Higher Reliability: MTBF to 500,000 hours with conservative design criteria including NAVMAT guidelines.

MORE CHOICES

- Up to 8 DC outputs to 500 watts.
- 1 ϕ , 3 ϕ and DC inputs.
- -55°C to +85°C operation.
- Mil-Std-704A-D, 1399 and 1275 input surge and spike protection.
- Meets many provisions of Mil-Std-810D, Mil-E-5400 and Mil-E-16400.

Call or write for our new EL 2000 Catalog today!



ARNOLD MAGNETICS CORPORATION

4000 Via Pescador, Camarillo, California 93010-5049

Phone: (805) 484-4221 • TWX 910-343-6468 • FAX: (805) 484-4113

the modem's configuration data. Syncro-24-PS, £545; Syncro-48-PS, £645.

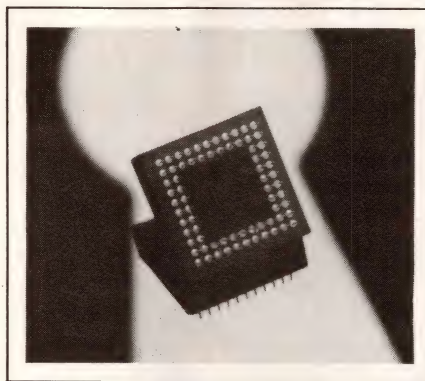
Mayze Systems Ltd, Delta 900, Great Western Way, Swindon, Wiltshire SN5 7XQ, UK. Phone (0793) 511789. TLX 445707.

Circle No 355

ENCRYPTION KEY

- *Protects against unauthorized access of data*
- *Meets NSA's communication security requirements*

The Smart Key encryption device prevents unauthorized data access. This key-like device provides eight pairs of redundant gold contacts that plug into a 16-pin socket. It contains a 12-MHz CMOS μ P with ROM for program storage and a 16k- or 64k-byte EEPROM. With the key inserted in a system, you can initialize a new key number,



write a record into memory, read a record from memory, read a status register, compute a checksum, read the key number assigned during initialization, and erase the data storage area. The unit measures $5.08 \times 2.54 \times 1.27$ cm and weighs less than 12g. It meets NSA's communications security (COMSEC) requirements. \$375 (OEM).

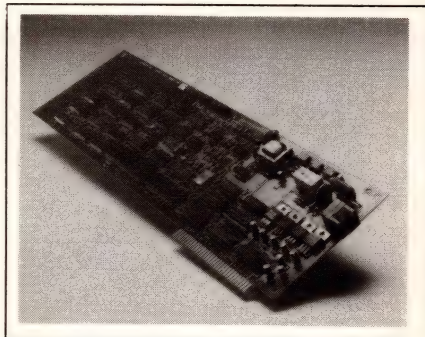
Tracor Inc, 6500 Tracor Lane, Austin, TX 78725. Phone (512) 926-2800.

Circle No 356

VOICE PROCESSOR

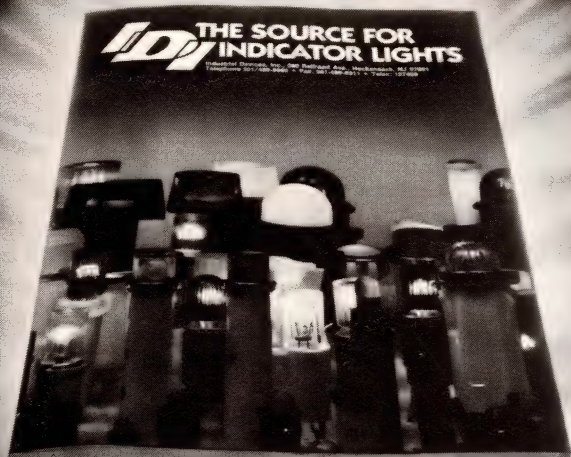
- *Has an 8k-sample/sec μ -law codec*
- *Compresses voice data 2 to 1, using 32k-bps ADPCM encoding*

The AVA (Automated Voice Administrator) single-slot IBM XT and AT board for processing voice communications has an 8k-sample/sec μ law codec; it compresses voice data 2 to 1, using adaptive differential-pulse-code modulation (ADPCM) encoding. It compresses data further by deleting silent periods and



LIGHT YEARS AHEAD.

IDI THE SOURCE FOR INDICATOR LIGHTS



IDI's free 224 page Databook brings you the broadest and most complete line of indicator lights and LED's. In its pages, you'll find solutions to design and application problems...even learn how to cut assembly costs. So call... (201) 489-8989 or FAX us at (201) 489-6911 for your free copy. **Bright Ideas from**



Industrial Devices, Inc. Hackensack, N.J. 07601

CIRCLE NO 164

Lock out trouble.



Looking for a miniature circular connector you can trust in critical applications? SNAPLOCK is your answer. It's rugged and reliable, with a positive action quick-release locking mechanism. That means it will stay connected until you release it. Period. Available in three shell sizes. Up to 7 contacts in a 1/2-inch diameter shell. They're even available in environmentalized and hermetic versions.

If your application calls for a reliable compact connector, find out how SNAPLOCK can solve your problems. Call or write today for a free catalog.

CRITON VIKING

SNAPLOCK MINIATURE CIRCULAR CONNECTORS
21001 Nordhoff St., Chatsworth, CA 91311 • (818) 341-4330

CIRCLE NO 165

VETERANS OF MANY CAMPAIGNS



Eternacell® lithium cells and batteries have powered many projects for the military in the last seventeen years. High-rate, low-rate, reserve, and thermal systems perform in every terrain at temperatures from -55°C to $+100^{\circ}\text{C}$. We're the veterans in design, qualification, and production, and the largest

producer of lithium cells and batteries in the U.S. Need a proven veteran for your project? Call (201) 796-4800; Telex 13-0292. Or write to 495 Boulevard, Elmwood Park, NJ 07407.

ETERNACELL®
Power Conversion, Inc.

CIRCLE NO 166

SWITCH MODE POWER FIT FOR YOUR NEEDS

Case 21

750 Watts
5"x6.5"x10
Single Outputs
Up to 5V 150A
15A Auxiliary Mag
Amp Outputs

The power and flexibility you'd expect from 5X8X11 "slot" switching power supplies is now available with room to spare with the Qualidyne Case 21. Delivering 750 Watts from 1 to 7 fully regulated outputs. A unique package design that makes system connections a snap. A full assortment of standard features and options plus safety approvals and compliance with worldwide standards. Cut your power supply down to size with the Qualidyne Case 21.



THE SWITCHER FIT FOR YOUR NEEDS

Qualidyne
Qualidyne Systems, Inc.
3055 Del Sol Boulevard, San Diego, CA 92154
(619) 575-1100 Telex: 709 029 FAX: 619 429 1011
(800) 445-0425 In Calif. (800) 237-6885

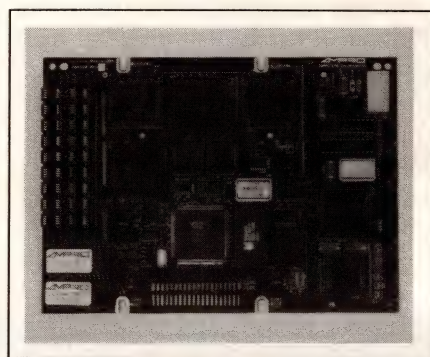
CIRCLE NO 178

COMPUTERS & PERIPHERALS

restoring them on transmission. A telephone interface has ring detection, DTMF reception and dialing, and call progress tones. Its features include an unattended answering routine, unattended directory assistance, personalized messages, call screening, and an information bulletin board. Customized software lets you adapt the system to user protocols. \$1100.

Zymacom Inc., 2 Lyberty Way, Westford, MA 01886. Phone (617) 692-4500.

CIRCLE NO 357



MOTHER BOARD

- Performs IBM PC/AT mother-board functions in 46 in³
- Employs a 3-chip set and consumes 8W

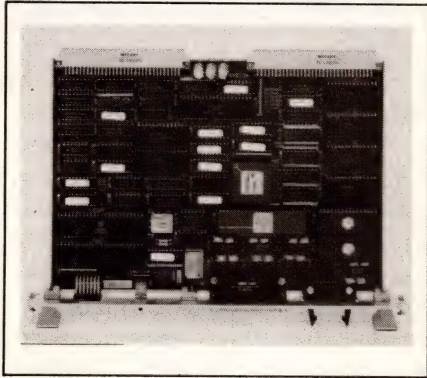
The Little Board/286 mother board performs the functions of an IBM PC/AT computer in 46 in³. It measures $8 \times 5\frac{3}{4} \times 1$ in. The board employs a 3-chip set, called the 286 AT, which permits the integration of an AT-compatible system with 13 ICs. The board consumes 8W and operates from 0 to 70°C . It lets you substitute bubble memory, EPROM, and nonvolatile RAM for disk drives in embedded applications and harsh environments. The board comes with an 8- or 12-MHz 80286 CPU, an AT-compatible BIOS, a 512k- or a 1M-byte dynamic RAM, and a floppy-disk controller for two $5\frac{1}{4}$ - or $3\frac{1}{2}$ -in. disk drives. In addition, it has two RS-232Cs serial ports, a parallel port, a keyboard port, three counter/timers with

COMPUTERS & PERIPHERALS

seven DMA channels, and 16 levels of interrupts. \$739 (OEM).

Ampro Computers Inc., 1130 Mountain View, Alviso Rd, Sunnyvale, CA 94089. Phone (408) 734-2800. TLX 4940302.

Circle No 358



COMM BOARD

- Provides X.25 communication over wide-area networks
- Implements layers 1 to 3 of the OSI communications model

Simplifying the software that you have to write during systems integration, the CC-125 VME Bus X.25 communications card conforms to the X.213 specification for data transfer to layer 4 functions of the OSI (open systems interconnection) model. The board implements layers 1 to 3 of the OSI model. Layer 1 operates according to the X.21 bis (V.24/V.28) standard, and layer 2 to the LAPB (link access procedures balanced) protocol standard. The board's layer 3 software handles the X.25 packet-level protocol and imposes flow control to prevent the communications link from overloading. Messages are passed between the CC-125 and the VME Bus system's layer 4 functions via dual-port RAM on the CC-125. These messages, coded according to X.409 recommendations, are transferred to the dual-port RAM in the form of network-service data units that can be as much as 4k bytes long. The 68000-based board is suitable for transmitting packet-switched data over public or private data networks

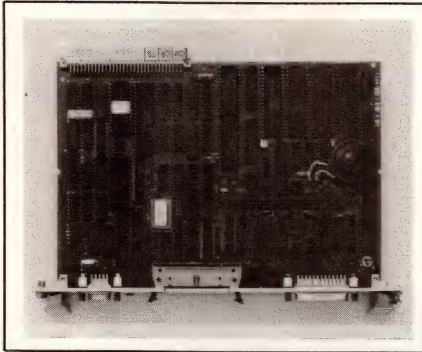
at bit rates as high as 64k bps. \$3675.

Compcontrol bv, Stratumseindijk 31, 5600 AD Eindhoven, The Netherlands. Phone (040) 124955. TLX 51603.

Circle No 359

Compcontrol Inc., 15466 Los Gatos Blvd, Suite 109-365, Los Gatos, CA 95032. Phone (408) 356-3817. TWX 510-601-2895.

Circle No 360

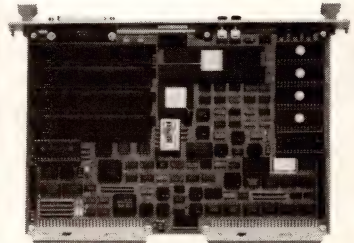


INDUSTRIAL PC

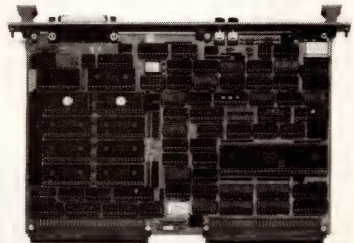
- Puts an IBM PC/AT-compatible in VME Bus systems
- Allows memory expansion to 16M bytes

The PX4000 VME Bus module allows you to implement an IBM PC/AT-compatible computer in VME Bus systems. The 2-board sandwich runs an 80286 μ P and an optional 80287 math coprocessor at 8 MHz. It includes all the ports you'd expect to find on a standard PC/AT—that is, a keyboard, a monitor, a printer, and floppy-disk interfaces—and runs the MS-DOS operating system. However, the module's video output provides an IBM CGA-compatible interface as standard. In addition to accessing the board's 512k bytes of onboard dynamic RAM, processor and DMA channels can transparently access additional memory via the VME Bus. If you use the μ P's protected addressing mode, it can access as much as 16M bytes of memory. The onboard RAM is also accessible to other VME Bus masters. A hard-disk controller board that operates in conjunction with

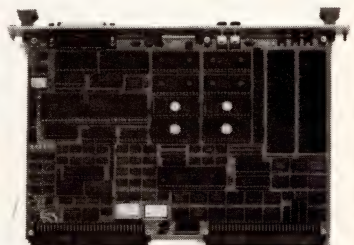
TL Industries VMEbus CPUs—100% MOTOROLA MVME COMPATIBLE ENHANCED PLUG-IN REPLACEMENTS



- **TVME 1611** (MVME 117-3 Compatible)
Up to 4 MB DRAM



- **TVME 1612** (MVME 110-1 Compatible)
System Control at 8 or 10 MHz



- **TVME 1613** (MVME 110-1 Compatible)
Up to 1 MB Shared DRAM

TL Industries also offers contract manufacturing capabilities, including surface mount technology, custom design, and software services. Please call or write for more information.



Industries Inc.

TL Industries, Inc.
2541 Tracy Rd.
Toledo, OH 43619
Call Meg Niehaus
1-800-227-8144 (outside Ohio)
or 419-666-8144
FAX 419-666-6534

CIRCLE NO 179

253

the PX4000 is also available. \$2500.

Philips, Industrial and Electro-Acoustic Systems Div, 5600 MD Eindhoven, The Netherlands. Phone (040) 788620. TLX 35000.

Circle No 367

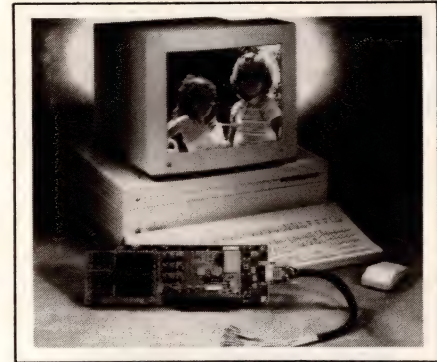
Philips Electronic Instruments Inc., 85 McKee Dr, Mahwah, NJ 07430. Phone (201) 529-3800.

Circle No 361

FRAME GRABBER

- Displays color motion pictures on the Macintosh II
- Captures 640×480-pixel images with 32,768 colors

The ColorCapture plug-in frame grabber board for the Macintosh II computer captures color images from video cameras, VCRs, or still-



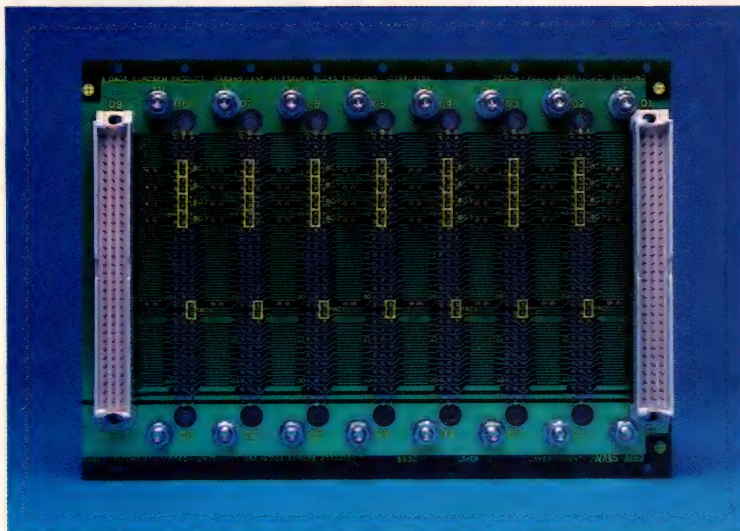
video equipment. It displays them in 1/30 sec (real time) on a video monitor. The board captures 640×480 square-pixel images and can display them in 32,768 colors. The board lets you edit images, add text or graphics to color video, output to a video tape, sharpen or soften edges, build multiple images, and perform animations. An external trigger lets you synchronize captured images with other events. A zoom, pan, and scroll controller provides real-time magnification. The 60-Hz DT2270 version comes with an NTSC composite output and outputs for the three RS-170 RGB signals. The 50-Hz DT2270 version provides PAL composite output and the three CCIRR RGB outputs. \$2995.

Data Translation Inc., 100 Locke Dr, Marlboro, MA 01752. Phone (617) 481-3700. TLX 951646.

Circle No 362

WHY WASTE ENCLOSURE SPACE?

Available In
4, 5, 7, 9, 13, 14, 17 & 21 Slots



When placed next to your disk drives, Dage's NEW 13-Slot Backplane provides maximum use of space in a 19-inch rack.

For maximum power, standard input is via press-fit, threaded studs (spade lugs optional).

And, to meet your specific needs, Dage will customize

to meet your requirements.

Dage offers both J1 & J2 multilayer backplanes with the following exceptional characteristics:

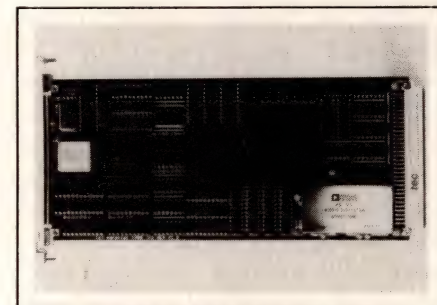
- ☐ Impedance - 60Ω (±2)
- ☐ Capacitance - 77 pF (±3)
- ☐ Crosstalk - <200 mV



DAGE PRECISION INDUSTRIES, Inc.

46701 Fremont Blvd.
Fremont, CA 94538 (415) 683-3930

CIRCLE NO 180



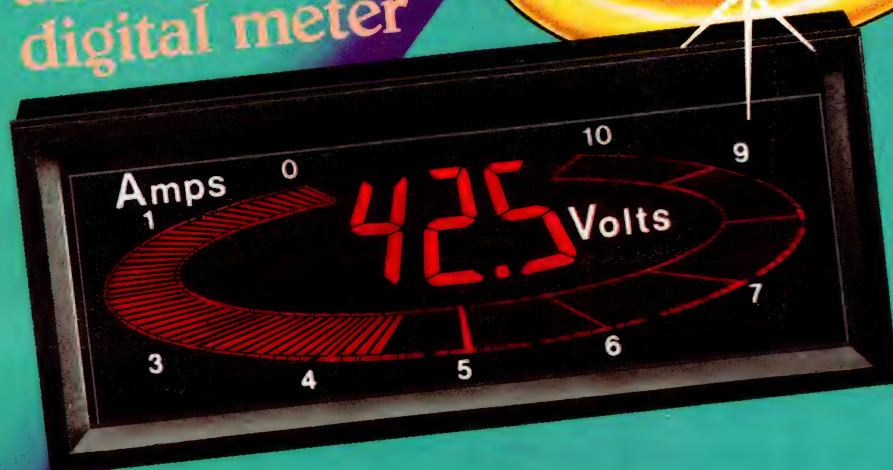
IMAGING BOARD

- Digitizes up to 256 gray-scale levels
- Provides 768×512-pixel max resolution

The TFG single-Eurocard image processing module includes a frame grabber, a frame store, a

A MARRIAGE MADE IN NEW HAMPSHIRE!

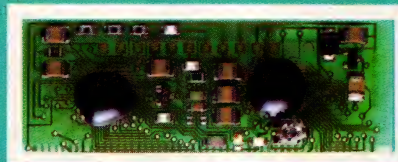
Modutec's
analog and
digital meter



THE FIRST 2 IN 1 'BIG-LITTLE' METER BREAKTHROUGH!

All brides have a special glow as they walk down the aisle, but the new BGE Series meter gets its brightness from Modutec's exclusive Big-Little LCD, with LED backlighting. A big 0.34" digital readout and 101 segment, superfast 3½" bargraph provides 2 readings in one meter and the case is only 2.5" x 1" x 0.5" deep. Now that's a major breakthrough in analog and digital panel meter technology! Separate inputs to the numerical and bargraph displays; and customized scales and nomenclature, make it ideal for power supplies, UPS systems and all applications measuring either one or two parameters.

For power, choose 5V DC or a 9V battery. Bargraph is accurate to 1% typical and the digital reading is accurate to 0.1% typical. To get a perfect analog/digital marriage, all you have to say is "I do." You'll agree, Modutec's new BGE Series is a meter marriage made in...New Hampshire!



The inside story! Modutec's chip-on-board technology.



MARRIED AND MADE IN THE USA!

MODUTEC

920 CANDIA ROAD, MANCHESTER, NH 03103-9916.
603/669-5121. FAX: 603/622-2690. 1-800-METERS-1

CIRCLE NO 181

Transputer to process the image, a color look-up table, and video output. The board accepts CCIR and RS-170A video signals and digitizes them to 256 gray-scale levels with a 768x512-pixel max screen resolution. You can externally or internally synchronize the frame grabber and cascade boards to capture RGB color inputs. The board stores the image on a 0.5M-byte video RAM. It provides an additional 1M byte for the onboard T800 or T414 Transputer. The color look-up table lets you generate color images containing 256 colors from a palette of 262,144 colors. Four 20M-bps Transputer links allow the Transputer to communicate with other processors. By using adapter modules you can insert the board into an IBM PC, or couple it to a VME Bus, a Q bus, or a Nu bus. The vendor's software support includes compilers for Occam, C, Fortran, Pascal, Parallel Prolog, and the He-

lios Transputer operating system. DM 7800.

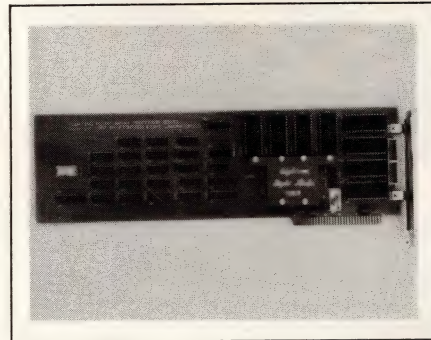
Parsytec GmbH, Juelicher Strasse 338, 5100 Aachen, West Germany. Phone (0241) 166000. FAX (0241) 1660050.

Circle No 363

ARRAY PROCESSOR

- Provides 8M 32-bit flops on IBM PCs and compatibles
- Contains a 60k-byte cache for program and data

The PL800 is an array-processing board for the IBM PC, PC/XT, PC/AT, and compatibles. A floating-point engine contains a 32-bit floating-point multiplier, a 40-bit ALU, and four 40-bit accumulators. The multiplier and ALU are in a pipeline and operate in parallel. This combination can perform 8M 32-bit flops. The board also contains a 16-bit RISC (reduced instruction set com-



puter) Integer Processor, a 60k-byte cache for program and data, a host interface processor, and an auxiliary interface processor. A 32-bit instruction fetch, two 32-bit data fetches, and a 32-bit store occurs within 244 nsec. You can use from one to eight boards by writing control programs in Fortran, C, or Pascal. PL800 with support software, \$1995.

Eighteen Eight Laboratories, 771 Gage Dr, San Diego, CA 92106. Phone (619) 224-2158.

Circle No 364

Thermography enters

With the advent of the Hughes Aircraft Company Probeye® 7300 Thermal Video System, thermal imaging has entered a new age—the Age of Information.

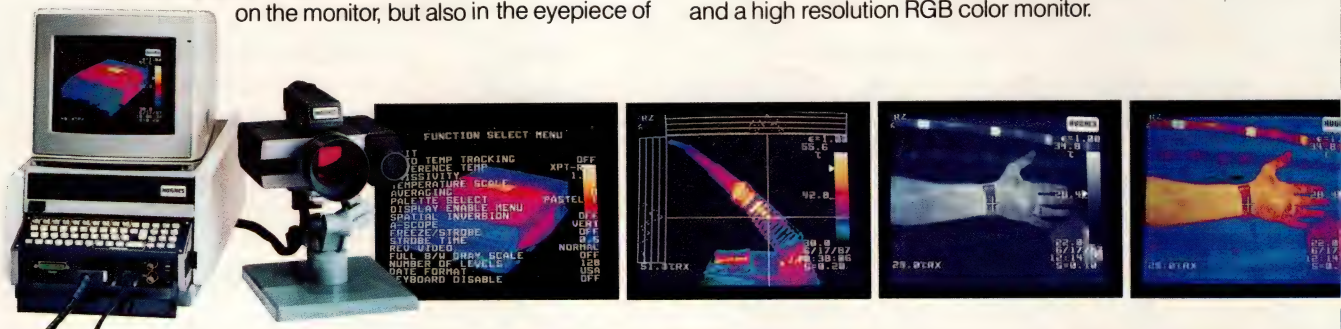
In a single package, the Hughes Probeye 7300 Thermal Video System gives you a powerful, intelligent laboratory system with instant field diagnostic capability. Immediately select, store, quantify and analyze. And, most importantly, *understand* the information—with more speed and accuracy than ever before! Hughes has leapfrogged the competition with state-of-the-art features that can't be matched by any other system.

Start with superior resolution—240 infrared lines. Not just on the monitor, but also in the eyepiece of

the portable imager. Which means you can perform on-the-spot detection and analysis in up to 128 distinct levels.

All-electric operation does away with liquid nitrogen or argon gas. The imager uses ac or battery power for full field portability—it goes wherever the information originates.

Fully automatic operation allows you to concentrate on detection and analysis. Precise comparisons are facilitated by built-in features. There's no exhaustive training process. No delays. Just point and read. And, the design is extremely functional—in addition to the portable imager and attached CRT viewfinder, the system includes a processor with built-in, full-function keyboard and a high resolution RGB color monitor.



VME BUS SBC

- Features a 33-MHz 68030 CPU and a VSB interface
- An 8-bit extension bus lets you add plug-in modules

The 68-31 single-board computer for the VME Bus in a single-slot, double Eurocard form factor features a 33-MHz 68030 CPU and the VME Subsystem Bus (VSB) interface. The additional interface lets you dedicate different operations to either the VSB or the VME Bus for optimum bus utilization. The board contains 4M bytes of dual-ported dynamic RAM, an optional 68882 floating-point coprocessor, a cache capable of burst fills with zero wait states, two synchronous or asynchronous serial ports, mailbox interrupts, and a Processor EXtension bus (PEX). The PEX bus is an 8-bit asynchronous bus linked to the CPU that lets you add more functions via plug-in modules. Modules with

SCSI or floppy-disk interfaces are available. The board complies with the VME Bus IEEE-1014 standard and operates as a 32-bit address/data bus master. \$4295.

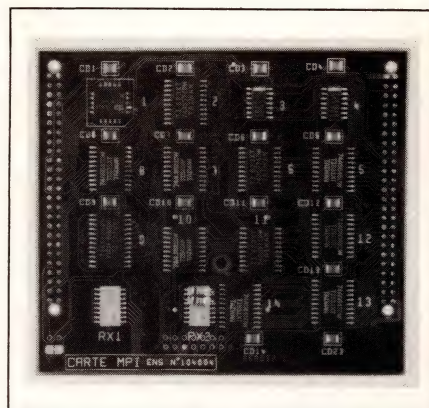
Radstone Technology, 1 Blue Hill Plaza, Pearl River, NY 10965. Phone (800) 368-2738; in NY, (914) 735-4661.

Circle No 365

INTERFACE MODULE

- Lets you interface I/O boards to the iPSB bus
- Sends and receives iPSB messages

The MPI module lets you interface I/O cards to the Multibus II iPSB. This 81.3×80×12.3-mm module needs two I/O card connectors. It occupies a single slot. The module's iPSB interface can send or receive normal or broadcast messages without data fields. In the I/O space, the



board provides for 8- or 16-bit data transfers and a 2k-byte board address region. In the interconnect space, the module provides 32 header registers, which you can program using an EEPROM. The interface module doesn't require I/O-board firmware. Approximately \$220.

Centralp Automatismes, 16 rue Gabriel Péri, 92120 Montrouge, France. Phone (1) 42533617. TLX 632380.

Circle No 366

the information age

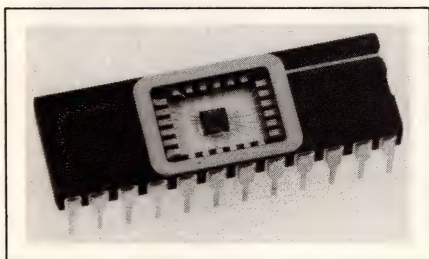
For details, specifications, and a hands-on demonstration, call or write today. We'll show you how a single system solution can put you into, and on top of, the Age of Information. Hughes Aircraft Company, Probeye Marketing, 6155 El Camino Real, Carlsbad, CA 92009, (619) 931-3617.



HUGHES
AIRCRAFT COMPANY

NEW PRODUCTS

INTEGRATED CIRCUITS



GaAs DIGITAL ICs

- Pin-compatible with 100K ECL
- Minimized propagation delay

Fabricated in the company's depletion-mode GaAs process, the G100113 quad driver, G100141 8-bit shift register, G100179 carry-lookahead generator, and G100180 6-bit adder are all drop-in replacements for 100K ECL types. Typical propagation delays are 500 psec for the quad driver, 1150 psec for the 8-bit shift register, 1000 psec for the carry-lookahead generator, and 1450 psec for the 6-bit adder. All of these high-performance digital ICs are compatible with ECL single power supplies of -4.5V (100K systems) and -5.2V (10K systems). Each is fully compensated for voltage and temperature variations. Samples are available now in 24-pin DIPs; flat-pack versions will be available in the fourth quarter of 1988. \$25 (G100113 and G100179), \$26 (G100141), and \$32 (G100180), (100).

Microwave Semiconductor Corp., 100 School House Rd, Somerset, NJ 08873. Phone (201) 563-6300. TLX 833473.

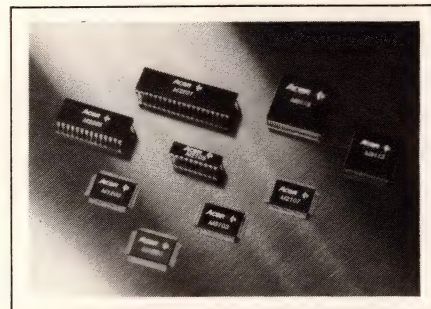
Circle No 400

PS/2 CHIP SET

- Contains 8 chips
- For IBM Models 25 and 30

The PC86 chip set provides the system-, graphics-, and peripheral-control functions needed to build a fully compatible PS/2 Model 25 or 30. The chip set's architecture and partition-

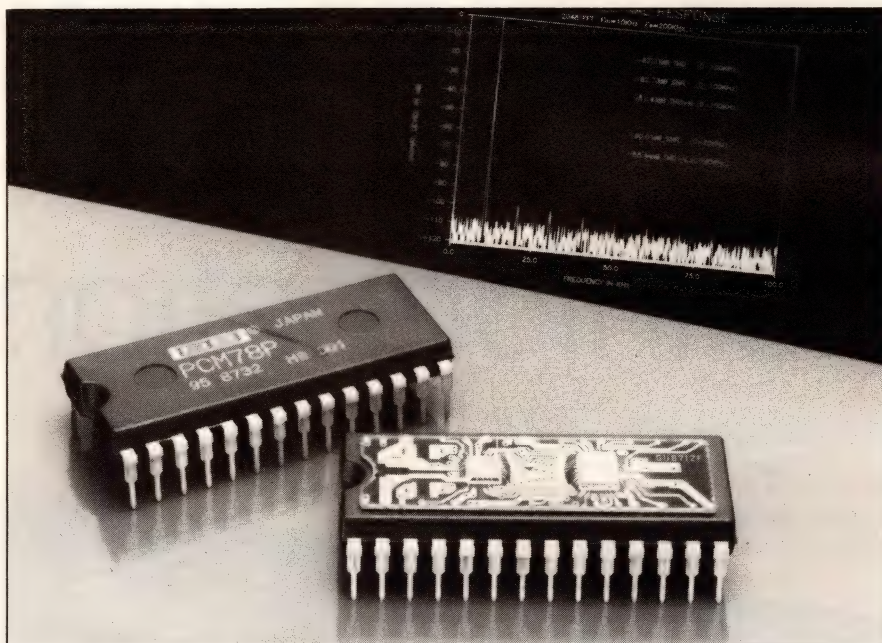
ing simplify manufacturing and reduce costs by making it possible to use only a few chips to build a range of systems. The set consists of the M1201 system controller for the 8086 and V30; the M1203 address and data buffer; the M2107 input/output controller; the M3113 and M3115 MCGA and Hercules graphics controllers; the M3205 50-MHz, 256×18 -color palette; the M2201A bidirectional printer interface; and the M5103 floppy-disk-drive interface. You can use the graphics-control and peripheral-control chips separately for PC/XT and PC/AT



computers. A PC86 sample set costs \$88; \$77 (1000).

US Sertek, 926 Thompson Pl, Sunnyvale, CA 94086. Phone (408) 733-3174.

Circle No 401



16-BIT AUDIO ADC

- 4- μsec conversion time
- Typical THD+N of -88 dB

The PCM78P 16-bit successive-approximation A/D converter has a typical total-harmonic-distortion-plus-noise (THD+N) spec of -88 dB (-82 dB max) at full scale. The chip is designed and tested for dynamic applications. The chip uses bipolar circuitry for its precision analog portion and low-power CMOS for its logic and clock functions. It features

a typical 4- μsec conversion time (5 μsec max). The PCM78P's $\pm 3\text{V}$ input range interfaces to S/H amplifiers, and its two serial-output modes facilitate interfacing. The chip includes an internal clock and reference, is 100% tested to data-sheet specifications, operates from ± 5 to $\pm 12\text{V}$ supplies, and dissipates 600 mW. \$39.90 (100).

Burr-Brown Corp., Box 11400, Tucson, AZ 85734. Phone (602) 746-1111. TLX 666491.

Circle No 402

What's so special about our 8 BIT microcontrollers? (Only our customers know for sure.)



And it's no wonder they want to keep it to themselves.

Not only is MHS one of the world leaders in CMOS microcontroller technology, with over 7 million units delivered to date. We're also one of the fastest suppliers, delivering both standard and customized parts to our customers' doorsteps – anywhere in the world – in no time flat.

It would seem that they appreciate it. Our customers have made us the No. 3 supplier of 80C51 microcontrollers worldwide. In Europe, they've made us No. 1.

That's not all. The MHS product line gives our customers unrivalled freedom of choice.

Do they want 4, 8 or 16 Kbytes of ROM? No problem. 32 K? We can do it. On-chip RAM: 128 or 256 bytes? Their wish is our command.

Part-number	ROM (Kbytes)	RAM (bytes)	Timers	Special features
80C51	4	128	2	Quick ROM 18 MHz
80C52	8	256	3	Quick ROM 18 MHz
83C154	16	256	3	Extra modes
83C158	32	256	3	Extra modes
80C752	4	128	2	Keyboard controller

They can also choose from a range of operating clock speeds from zero all the way up to 18 MHz, or from our full choice of packages and temperature ranges. Not to mention low-voltage (down to 2.7 V!) or "Secret ROM" versions.

With the MHS "Quick ROM" service, they have customized samples or production parts sitting on their desks in just two or three weeks. ROMless 80C31/32 parts are there before they even know it.

So next time our customers get out of hand, you'll understand why.



**The best-kept secret
in semiconductor technology.**

MATRA DESIGN SEMICONDUCTOR
2895 Northwest Parkway
SANTA CLARA CA 95015, USA
Tel.: 408-986 9000 - Tlx 299 656

MATRA HARRIS SEMICONDUCTEURS
BP 309
78054 SAINT-QUENTIN-EN-YVELINES CEDEX
FRANCE - Tel.: (1) 30.60.70.00 - Tlx 697 317

MHS. A subsidiary of the MATRA Group

"I'M A TRUE BELIEVER IN THE POWER OF EDN MAGAZINE."

Robert E. Sanders
Manager, Marketing Communications
Rogers Corporation

Bob Sanders is a pro at marketing materials and components for Rogers Corporation, a worldwide leader with divisions from Connecticut to Arizona. To do the best job, he uses EDN magazine.

How come?

"EDN never fails for us. The magazine is targeted to markets we want to reach, like industrial controls and telecommunications. The result is unsurpassed inquiries for sales lead follow-up."

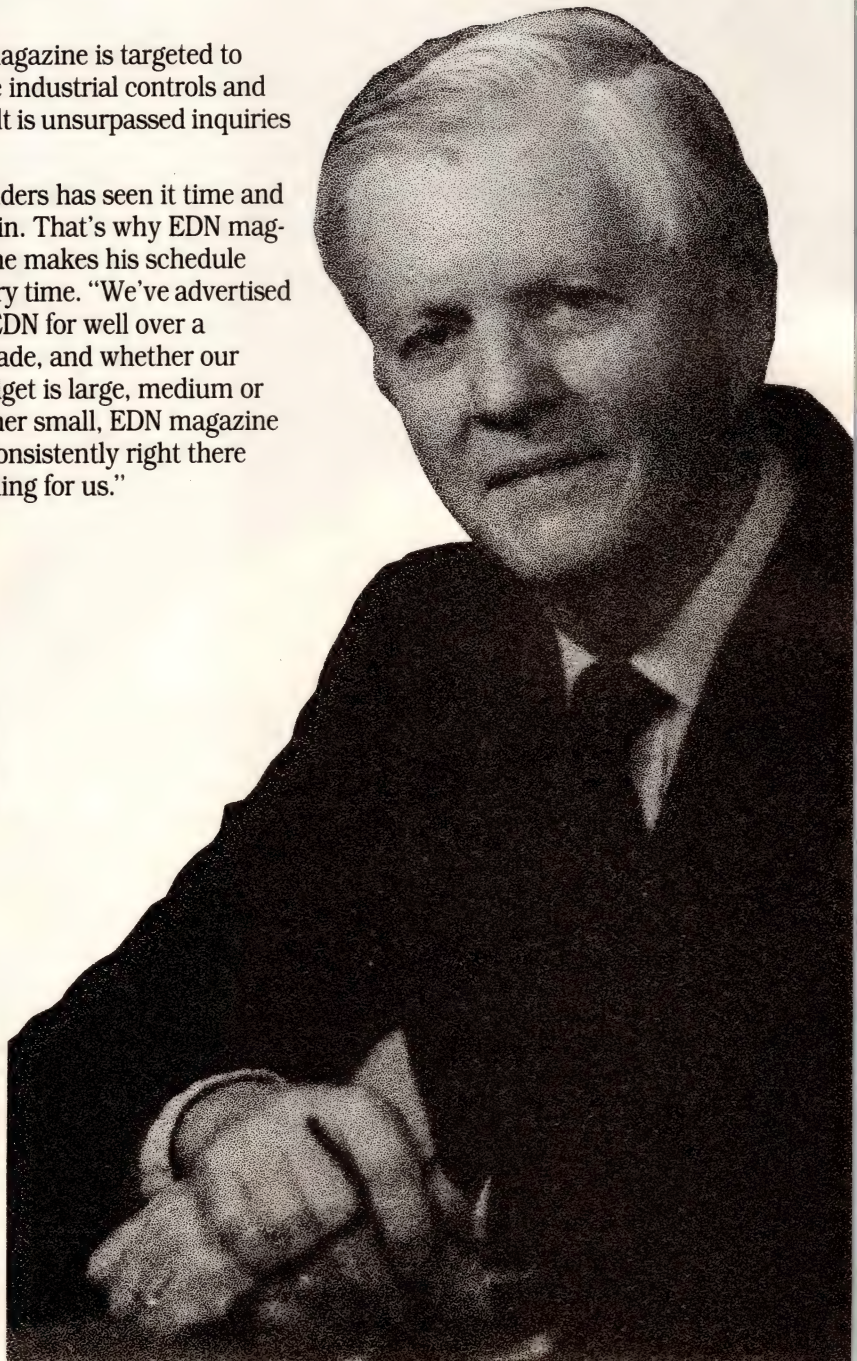
Sanders has seen it time and again. That's why EDN magazine makes his schedule every time. "We've advertised in EDN for well over a decade, and whether our budget is large, medium or rather small, EDN magazine is consistently right there pulling for us."



Advertising in EDN magazine works for Rogers Corporation. It can work for you.

EDN

Where Advertising Works



EDN INFO CARDS

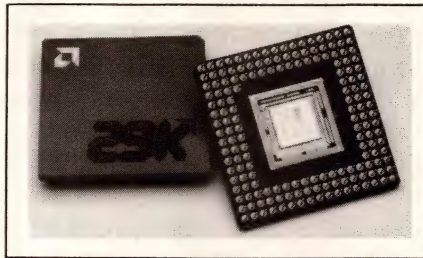


- Offer an ideal way to:
- Introduce new products.
 - Build awareness in the marketplace.
 - Supplement your advertising campaign.
 - Promote catalogs, literature or price sheets.
 - Test an advertising message.

For further information, contact Lauren Fox, EDN Info Cards Manager, at (203) 328-2580.

*Numbers represent actual responses.

INTEGRATED CIRCUITS



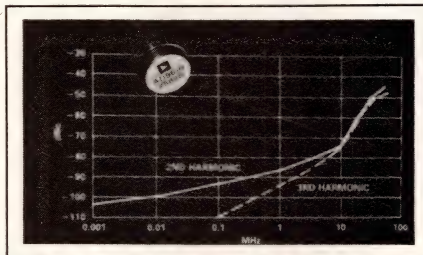
32-BIT RISC μ P

- 16- to 25-MHz versions
- 11- to 17-MIPS performance

The Am29000 32-bit, RISC μ P is now available in three different speeds: 16 MHz (11 MIPS), 20 MHz (14 MIPS), and 25 MHz (17 MIPS). The company is also supplying samples at beta sites of a 30-MHz (20-MIPS) version. The 25-MHz version delivers 36,000 dhrystones, using the V1.1 benchmark with 8k bytes of instruction and data cache. It delivers 15 MIPS at 24,000 dhrystones using V1.1 with an inexpensive video RAM. The dhrystone benchmark represents the typical mix of instructions anticipated for large-integer applications. 16-MHz version, from \$174 (100).

Advanced Micro Devices Inc.
Box 3453, Sunnyvale, CA 94088.
Phone (408) 732-2400.

Circle No 403



100-MHz OP AMP

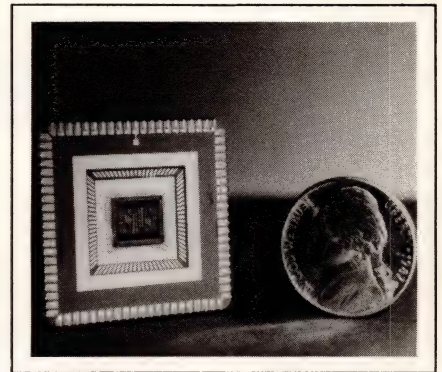
- Conforms to MIL-STD-883B
- Has 3000V/ μ sec slew rate

The AD9610 current-feedback operational amplifier is now available in a MIL-STD-883B version that is specified over the -55 to $+125^{\circ}\text{C}$ temperature range. The AD9610TH/883B offers a minimum -3 -dB bandwidth of 80 MHz and a maximum total-harmonic distortion

of -50 dB with a 20-MHz input tone. Rise- and fall-times are <4 nsec with a 5V step; the settling time is 25 nsec (max) to 0.1%. A minimum slew rate of 3000V/ μ sec is guaranteed. Maximum dc specifications at 25°C include: ± 1 -mV offset voltage, ± 15 - μ A inverting-node bias current, and ± 50 - μ A noninverting-node bias current. The AD9610TH/883B operates from ± 15 V supplies and comes in a TO-8 metal can. \$125 (100).

Analog Devices Inc., Box 9106,
Norwood, MA 02062. Phone (617)
329-4700. TLX 924491.

Circle No 404



SYNTHESIZER

- Has a resolution of 0.01 Hz
- 30-MHz input reference

The Q2334 single-chip digital frequency synthesizer provides a μ P interface to control variable frequency and phase signals that are synthesized from a master reference. It includes two independent frequency synthesizers for use in full-duplex systems, spread-spectrum analysis, or quadrature oscillator applications. The chip provides a resolution of more than 0.01 Hz with an input signal clocking the phase accumulator at 30 MHz. Signal-to-noise ratios are 72 dB for quantization noise and 76 dB for phase noise. The Q2334 is available in 68-pin packages. \$98 (1000).

Qualcomm Inc., 10555 Sorrento
Valley Rd, San Diego, CA 92121.
Phone (619) 587-1121.

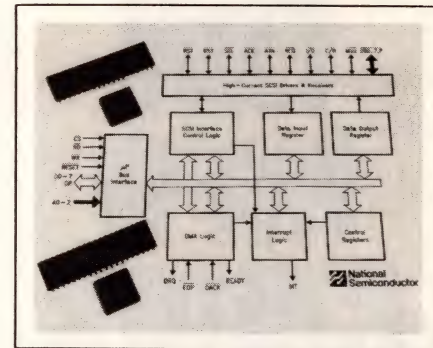
Circle No 405

CMOS SCSI ICs

- Pin-compatible with NMOS types
- 10-mA max supply current

Targeted at new and upgraded system designs, the DP8490 and DP5380 are CMOS devices that comply with the SCSI standard and are pin-compatible with the NMOS

NCR5380 device. The DP8430/5380 types operate from a 10-mA max supply current. The devices feature a typical acknowledge-to-request time of 60 nsec, and a typical request-to-acknowledge time of 30 nsec. The DP8490 features a DMA rate as high as 4M bytes/sec. It powers up as a 5380 device until an enhanced mode opens three regis-



Where CMOS Ends, DMOS Begins.

Enter the dimension of superior performance with the high-speed and high-voltage capabilities of DMOS from Topaz Semiconductor.

Our DMOS devices go beyond CMOS to provide the versatility you need for a wider range of applications, from subnanosecond switching to high-voltage power requirements. DMOS can speed through your toughest applications, or surpass the 40-volt reach of CMOS to extend your system capabilities up to 800 volts.

And Topaz has the DMOS products you need in a variety of configurations, from high-voltage DIP arrays to high-speed, surface-mount discrete devices.

Learn how our advanced DMOS devices can take you beyond the limits of CMOS. Call us today for a data book on our complete line of DMOS FETs, high-frequency analog switches and digitally controlled attenuators.

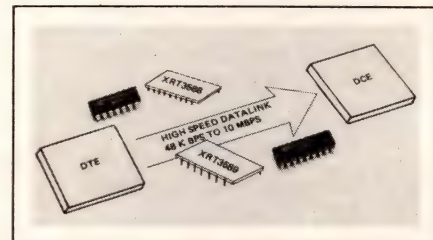
TOPAZ
SEMICONDUCTOR

Topaz Semiconductor, 1971 N. Capitol Avenue, San Jose, CA 95132-3799
TEL (408) 942-9100 TWX 910 338-0025 FAX (408) 942-1174

ters. Two registers control interrupts, and a third register, Extra Mode, has a sophisticated arbitration scheme that controls the use of the SCSI bus; μ P polling, as used with 5380 devices, is not required. A loop-back test mode allows users to fully test the device's functions, including DMA operation. The DP8490 also includes a phase-mismatch interrupt that detects a phase mismatch in any information transfer, decreasing dead-time on the SCSI bus. For users not making software changes, the DP5380 is available; it has the same speed and power features as the DP8490. The devices are available in 40-pin DIPs and 44-pin PLCCs. DP8490, \$8; DP5380, \$7.50 (100).

National Semiconductor Corp.
Box 58090, Santa Clara, CA 95052.
Phone (408) 721-4960. TLX 346353.

Circle No 406



INTERFACE CHIP SET

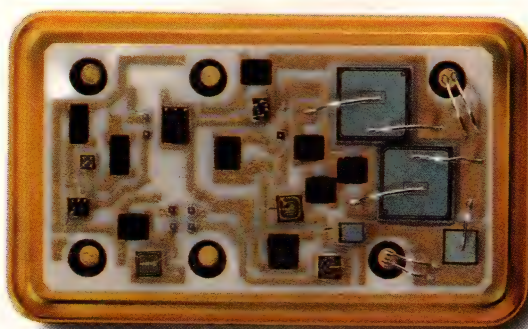
- CCITT V.35/Bell 306 compatible
- Data rates to 10M bps

The XR-T3588 (driver) and XR-T3589 (receiver) provide a communications link between data-terminal and data-communications equipment at rates from 48k bps to 10M bps. The XR-T3588 contains three independent drivers; the XR-T3589

SOLID STATE RELAY

Short Circuit Protection and True Output Status

- Current Overload Protection
- Optical Isolation
- TTL & CMOS Compatible Control
- DESC Drawing Number Pending

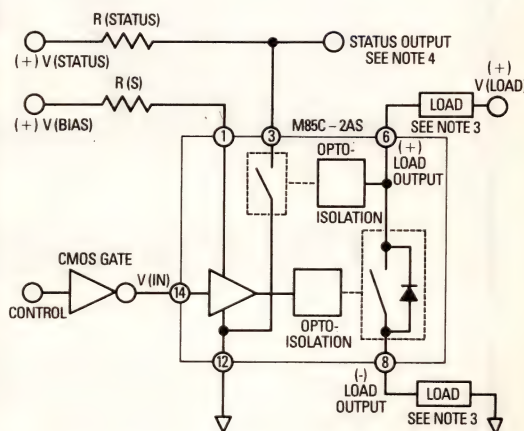


PART #M85C-2AS

ELECTRICAL CHARACTERISTICS (-55°C to +105°C unless otherwise noted)

	Min	Max	Units	
Bias Voltage (V_{BIAS})	3.8	32	V_{DC}	See Note 1
Bias Current (I_{BIAS})		15	mA	$V_{BIAS} = 5V_{DC}$
Control Voltage (V_{IN})	0	18	V_{DC}	
Control Current (I_{IN})		250	μA	$V_{IN} = 5V_{DC}$
Turn-Off Voltage	3.2		V_{DC}	-55°C to +25°C
$V_{IN(OFF)}$	2.8		V_{DC}	+25°C to +105°C
Turn-On Voltage		0.5	V_{DC}	-55°C to +25°C
$V_{IN(ON)}$		0.3	V_{DC}	+25°C to +105°C
Continuous Load Current		2.0	A	-55°C to +25°C
I_{LOAD}		400	mA	+105°C
Output Trip Current (I_{TRIP})	8 (TYP.)		A	+25°C, 100 ms
Continuous Load Voltage (V_{LOAD})		60	V_{DC}	
Output Leakage Current (I_{LEAK})		2	mA	
On-Resistance (R_{ON})		0.28	Ohms	
Turn-On Time (T_{ON})		3.0	ms	
Turn-Off Time (T_{OFF})		1.0	ms	
Status Voltage (V_{STATUS})	1	18	V_{DC}	
Status Current (I_{STATUS})		0.6	mA	See Note 2

Notes: 1. Series resistor is required for bias voltages above 6V_{DC}. $R_S = (V_{BIAS} - 5V_{DC})/15 \text{ mA}$
 2. A pull up resistor is required for the status output. $R_{STATUS} = V_{STATUS}/600 \mu A$
 3. Output will drive loads connected to either terminal (sink or source).
 4. Status output is low when the load output is off.



TELEDYNE SOLID STATE
A Division of Teledyne Relays

For immediate application assistance call 1-800-284-7007.

Teledyne Solid State, 12525 Daphne Avenue, Hawthorne, California 90250.

contains three independent receivers. Both ICs are TTL compatible and feature a power-down mode for each of the drivers and receivers. According to the company, the chip set is the first monolithic version to fully meet the CCITT V.35 requirements. The XR-T3588 comes in a 14-pin ceramic DIP; the XR-T3589 in an 18-pin ceramic DIP. \$4.18 (5000).

Exar Corp., Box 49007, San Jose, CA 95161. Phone (408) 434-6400. TWX 910-339-9233.

Circle No 407

18-BIT AUDIO DAC

- Includes deglitcher and reference
- Features 4× oversampling

Serving as the back-end of a digital audio system, the ZDA1801A 18-bit D/A converter includes a built-in deglitcher circuit and a voltage reference. The chip's guaranteed



front-to-back total harmonic distortion plus noise (THD+N) is 98 dB over the full 20-Hz to 20-kHz audio range. The ZDA1801A operates at a 4× oversampling rate. The DAC module comes in an electrostatic- and electromagnetic-shielded package with dimensions of 3.0×1.6×0.45 in. \$99 (100). Delivery, stock to six weeks ARO.

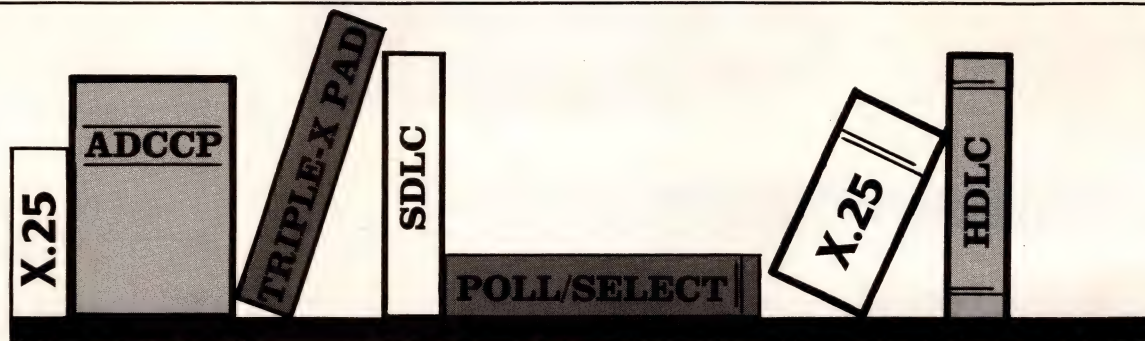
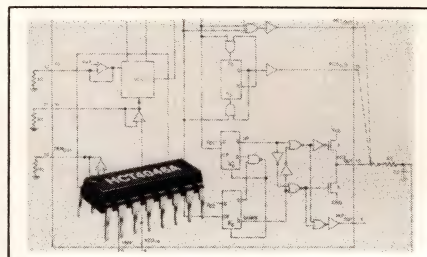
Analog Solutions, 85 W Tasman Dr, San Jose, CA 95134. Phone (408) 433-1900.

Circle No 408

PLL IC

- Has three phase comparators
- 0.4% frequency linearity

The CD54/74HC/HCT4046A PLL IC contains three different phase comparators—an exclusive OR gate, a J-K flip-flop, and an R-S flip-flop. Its VCO characteristics include a frequency linearity of 0.4% and a typical frequency stability of 0.11%/°C. The VCO operates at frequencies as high as 38 MHz, and a VCO-inhibit pin provides on/off control and limits power consumption when the PLL is in standby mode. A signal input and a comparator



Off the shelf protocol software.

Save time, save money with off-the-shelf protocol software from Gcom. We've been helping OEMs get their datacom products to market on schedule since 1980.

All our software is written in C to be hardware and operating system independent. Full source code is provided, and porting assistance is available.

With Gcom software handling protocol functions, you're free to concentrate on the parts of your project that can't be found on any shelf. For complete information, call Gcom today.

Specialists in Computer Communications



Gcom, Inc.

**41 East University Avenue
Champaign, Illinois 61820**

Phone (217) 352-4266

Telex 910-240-1477

FAX (217) 352-2215



NOTHING TAKES EVERYTHING YOU CAN DISH OUT LIKE MICRO/Q® 2000 CAPACITORS.

For applications in severe conditions, nothing can take whatever the environment dishes out like Rogers new Micro/Q 2000 Flat Ceramic Decoupling Capacitor.

Nothing takes the heat or cold or humidity like Micro/Q 2000 with its unique molded construction and X7R dielectric.

Nothing takes up less space because only the Micro/Q 2000 fits *under* DIPs to save valuable board space. Retrofittable to sim-

plify design. Supplied in anti-static tubes.

Nothing is as effective at reducing voltage noise spikes. Only Micro/Q 2000 provides the low-inductance and impedance levels necessary to reliable high-frequency decoupling.

The new Micro/Q 2000 from Rogers. Nothing you can design with works or fits like it—even in the harshest environments.



Fits under IC to save space.

Test results for MIL-C-39014D and MIL-STD-202F are available. Call or write a Rogers Micro/Q application engineer today for test results, free samples and technical information.

Another MEKTRON® interconnection component.



ROGERS

Rogers Corporation
Circuit Components Division
2400 South Roosevelt St.
Tempe, AZ 85282
Tel: (602) 967-0624
Fax: (602) 967-9385

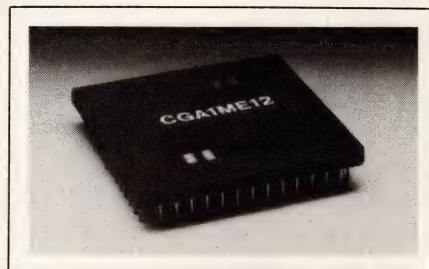
OUTSIDE THE U.S. CONTACT: Europe: Mektron NV, Ghent, Belgium Japan: Rogers Inoue Corp., Nagoya
Brazil: Rogers Coselbra, Sao Paulo Singapore, Hong Kong, Taiwan: Dynamar

input are common to all three phase comparators. You can couple the signal input directly to logic-level voltages or indirectly to millivolt-level signals through a series capacitor. The chip's self-bias circuit keeps small signals within the linear range of the input amplifiers. The CD54/74HC4046A operates from a 2 to 6V supply; the CD54/74HCT4046A op-

erates from a TTL-compatible 4.5 to 5.5V supply. Available packages include 16-pin ceramic and plastic DIPs and a 16-pin surface-mount version. In 16-pin plastic DIP, \$1.62 (100).

GE Solid State, Box 2900, Somerville, NJ 08876. Phone (201) 685-6562.

Circle No 409



ECL GATE ARRAY

- 4584 equivalent gates
- 3.5-nsec typical access time

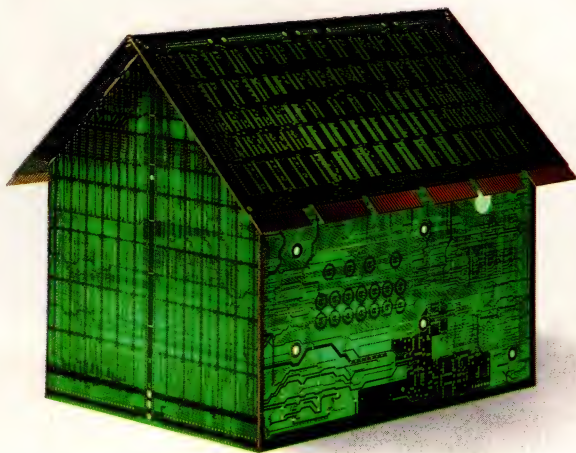
Featuring a typical access time of 3.5 nsec, the CGA1ME12 ECL gate array contains 4584 equivalent gates max, 1280 bits of configurable RAM, and 120 I/O cells. Interfaced among the I/O cells are 34 dedicated power pins. The gates are laid out in 12 contiguous rows with each row containing 1320 transistors and 1320 resistors. For the typical gate, the propagation delay is 300 psec, and the power consumption is 300 μ W. The RAM megacell consists of four separate blocks of 320 bits each. You can configure the RAM blocks independently or combine them to form larger memory blocks. Commercial versions of the device are specified for operation over the 0 to 70°C temperature range. Depending on gate utilization, quantity, and test requirements, prices start at \$150. Nonrecurring engineering costs range from \$40,000 to \$60,000.

Raytheon Company, Semiconductor Div, 350 Ellis St, Mountain View, CA 94043. Phone (415) 966-7639.

Circle No 410

PCB PROTOTYPES

Under One Roof



Now you can have speed, quality and a total premium service—under one roof.

Sun Circuits specializes in prototype printed circuit board fabrication and pilot runs. We're efficient and we're fast. From photoplotting to panelization, fabrication, hot air levelling and electrical test, Sun Circuits has it all in-house.

The next time you face a critical deadline or just want it now, call the experts at Sun Circuits, toll free, 800-PCBRUSH.



5191 Lafayette Street · Santa Clara, CA 95054 · (408) 727-7784

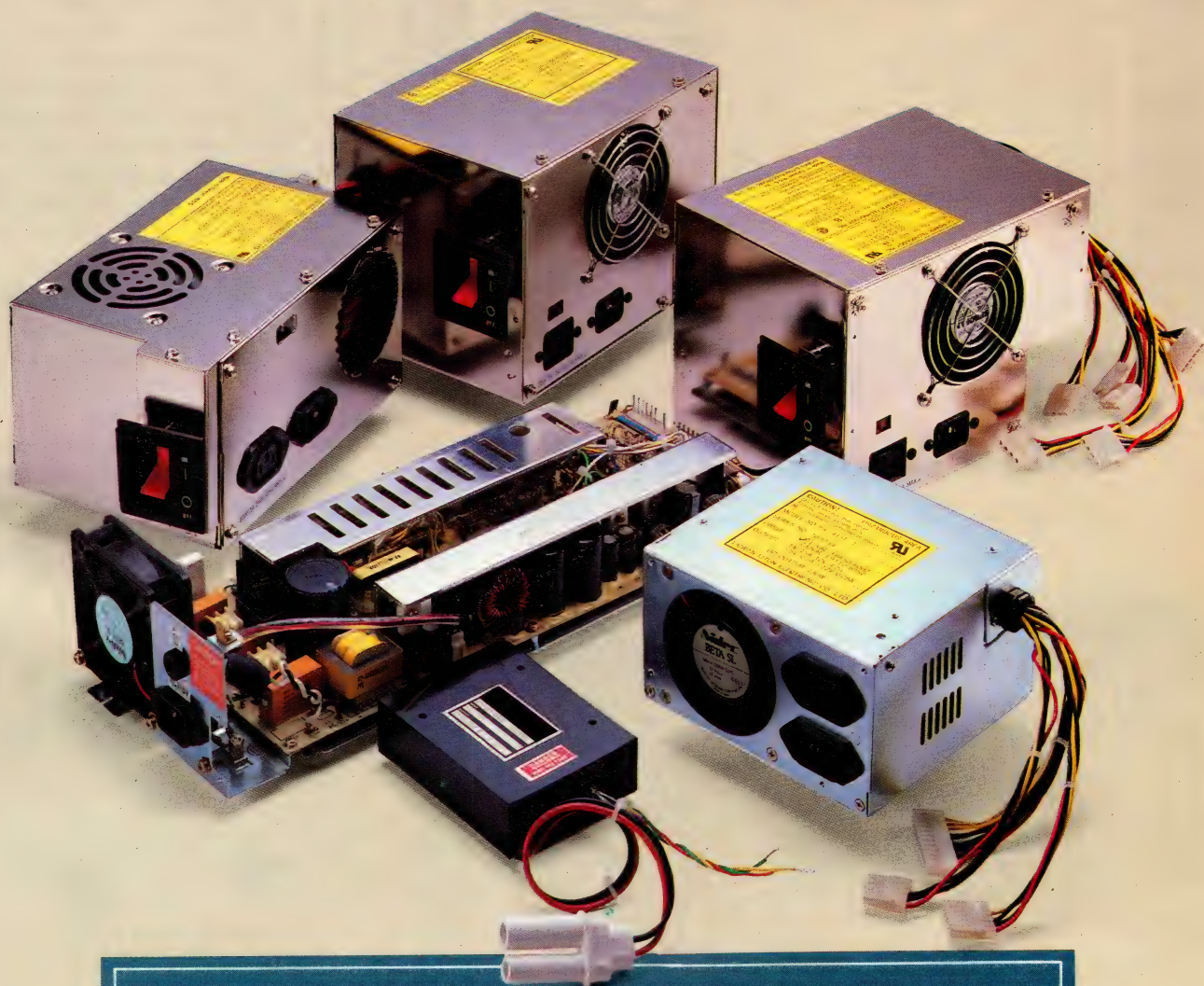
CHIP SET

- Includes multiplier and ALU
- Performs 60M flops

The B3110A-50 floating-point multiplier and B3120A-25 floating-point ALU comprise an ECL 10KH-compatible chip set that offers double-precision (64-bit) multiply operations in 50 nsec and add or subtract operations in 25 nsec. TTL-compatible versions are also available

Switch-On with Lite-On

Introducing 20 to 1000 Watt Power Supplies
that meet or surpass FCC, UL, CSA, TUV
and VDE Standards



When you are looking for the right solution to your switching power supply needs, consider the switch to Lite-On Inc. We offer a wide range of switching power supplies with many different electrical and physical options. Plus, we give you the most important "option" of all: reliability you can count on.

From our large, high volume manufacturing facility in Taiwan to our Northern California head-quarters, Lite-On is dedicated to serving our customers. For us, this means customer service, top engineering, attention to detail, high quality manufacturing, and stringent quality controls; for you, this means an affordable, no-problem power supply that lasts and lasts.

Lite-On Inc., Systems Division, also specializes in custom power systems. With our experience with design and high volume manufacturing of power supplies meeting or surpassing FCC class "B", UL, CSA, TUV and VDE standards, Lite-On can work with you to develop a power supply that can meet your specific needs.

With design support and high volume manufacturing, Lite-On is ready to help you meet your power needs. For more information, please call or write ...



Lite-On U.S.A., Inc.

Systems Division Attn: Sales Manager
726 South Hillview Drive, Milpitas, CA 95035
Tel: (408)946-4873 · Fax: (408)942-1527

CIRCLE NO 190

Taiwan Liton Electronic Co., Ltd.

12Th Fl., 25, Tunghua South Road, Taipei, Taiwan, R.O.C.
Tel: (02) 2226181-8 Telex: 34266 TWLITON Fax No.: (02) 2212780

INTEGRATED

Like the blades of a Swiss army knife, each works separately to fulfill a specific function. Together they form a complete set. Whitesmith's 68020 cross development toolkit works in the same way. Each component — C cross compiler, assembler, microprocessor simulator, and powerful support tools — alone solves a specific program development requirement. Used together, they provide you with a totally integrated environment for your software development. Your im-

mediate benefit from using integrated tools is optimized performance and improved programmer productivity. And when you use our toolkit together with an in-circuit emulator from one of today's leading manufacturers, you get a complete environment for developing and debugging 68K embedded programs in real-time. To receive more information on our cross development toolkit and an up-to-date list of compatible emulators, call our toll-free number, 800-225-1030. Within Massachusetts, call 508-692-7800.



WHITESMITHS, LTD.

CIRCLE NO 191

Custom quick rotaries.



Send us your specs and we'll prove it — free.

Our rotary switches' unique modular design means we can respond fast to your needs at a price you'll like...while giving you a circuit configuration that really works in your design.

Because our switches are enclosed, you don't have to worry about dust, dirt or moisture. Damaging solder flow or wicking is locked out, and lifetime lubrication is sealed in.

And because our manufacturing facility is vertically integrated, we

carefully control quality as well as response time during every step of our production process.

If you need rotary switches that are custom quick at a reasonable cost, let us supply you a FREE sample and quotation for your specific application.

Just contact your local Electro-switch representative, authorized distributor or the factory direct at P.O. Box 41129, 2510 North Blvd., Raleigh, NC 27604. Phone: (919) 833-0707. Fax: (919) 833-8016.

ELECTROSWITCH
UNIT OF ELECTRO SWITCH CORP. SOUTHERN OPERATIONS

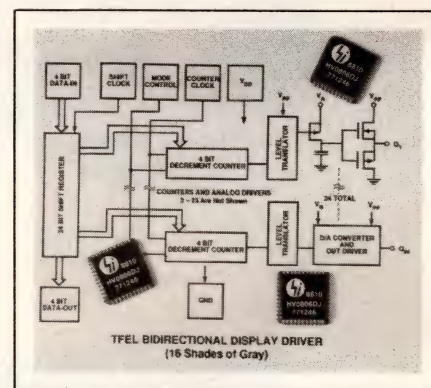
CIRCLE NO 192

INTEGRATED CIRCUITS

(B2110A-50 multiplier and B2120A-25 ALU). The set offers a combined performance of 60M flops and support DEC's F and G formats and IEEE-STD-754. The multiplier performs single-precision (32-bit) or double-precision (64-bit) floating-point multiply, divide, square-root, and 32×32 -integer operations in a single cycle. Worst-case multiply times are 40 nsec for single-precision and 50 nsec for double-precision. Worst-case division times are 180 and 300 nsec for single- and double-precision, respectively. The ALU performs add, subtract, integer-shift, rotate, arithmetic, and Boolean operations on 32- or 64-bit integers. Integer operations execute in 12 nsec. Packaging is in 169-lead pin-grid-arrays. \$565 (ECL), \$490 (TTL) (100).

Bipolar Integrated Technology Inc., 1050 NW Compton Dr, Beaverton, OR 97006. Phone (503) 529-5490. TLX 263097.

Circle No 411



DISPLAY DRIVER

- Column driver for TFEL displays
- Provides 16 shades of gray

Designed for high-resolution thin-film electroluminescent flat-panel displays, the HV08 column driver can provide 16 shades of gray. The chip includes four 24-bit shift registers, 24 4-bit counters, and 24 high-voltage S/H circuits to perform D/A conversion for any one of the 16 voltage levels that define the shades of gray. The HV08 is compatible

with all general-purpose EL display applications, including IBM PC and PS/2 formats. The chip is available in either plastic or ceramic 44-pin J-lead packages. Plastic package, \$9.96 (1000).

Supertex Inc., 1225 Bordeaux Dr, Sunnyvale, CA 94088. Phone (408) 744-0100. TLX 6839143.

Circle No 412

cess. The company guarantees the devices for a minimum of 100 erase-write cycles; it guarantees data retention for more than 20 years. Available packages are plastic DIP and plastic leaded chip carrier (PLCC). In plastic DIPs, the GAL16V8A-12 costs \$8.32; the GAL20V8A-12, \$9.51 (100).

Lattice Semiconductor Corp.

5555 NE Moore Ct, Hillsboro, OR 97124. Phone (503) 681-0118. TLX 277338.

Circle No 414

BUFFER AMPLIFIERS

- 125- and 200-MHz bandwidths
- 1500V/ μ sec slew rate

The EHOS-100 and EHOS-200 are high-speed, unity-gain buffer amplifiers with bandwidths (-3 dB) of 125 and 200 MHz, respectively. The EHOS-100 operates from ± 15 V supplies; the EHOS-200 from ± 5 V supplies. Included in each of the 2-stage amplifiers are bypass capacitors that improve the transient response. Both amplifiers feature a slew rate of 1500 V/ μ sec and can deliver 100 mA of output current. The buffer amplifiers come in TO-8 metal packages and are available in commercial and military versions. EHOS-100, \$10.13 to \$24.75; EHOS-200, \$9.38 to \$24 (100).

Elantec Inc., 1996 Tarob Ct, Milpitas, CA 95035. Phone (800) 821-7429; in CA, (408) 945-1323.

Circle No 413

PLDs

- 12-nsec propagation delay
- 100 erase/write cycles

The GAL16V8A-12 and GAL20V8A-12 are CMOS PLDs (programmable logic devices) with a maximum propagation delay of 12 nsec. As with all of the company's Generic Array Logic (GAL) products, these devices can replace any common 20-pin or 24-pin (PAL) device. The GAL16V8A-12 is a 20-pin device; the GAL20V8A-12 is a 24-pin device. The E²CMOS technology allows complete ac and dc testing during the manufacturing pro-



When your specs call for emission control, call for Emcor's EMI/RFI series



Emcor offers a choice of shielding solutions, all of which are tested to MIL STD 285. These enclosures combine high strength with modular options and attractive esthetics. Emcor's commercial EMI/RFI enclosures are fabricated from 14-gauge cold-rolled steel and are fully zinc-plated. Our Tempest-style enclosures provide even higher levels of attenuation. They are fabricated from 12-gauge cold-rolled steel, nickel-plated and feature a unique latching system and door design (patent pending).

Contact Emcor to discuss your EMI/RFI needs. Our engineering staff has the knowledge and experience to help solve shielding problems. We can also design modified and custom products.



Crenlo, Inc.

1600 - 4th Ave. N.W.
Rochester, MN 55901
Phone 507-289-3371
FAX #507-287-3405

EMCOR

See us at the MIDCON Show, Booth #244-246.

CIRCLE NO 193

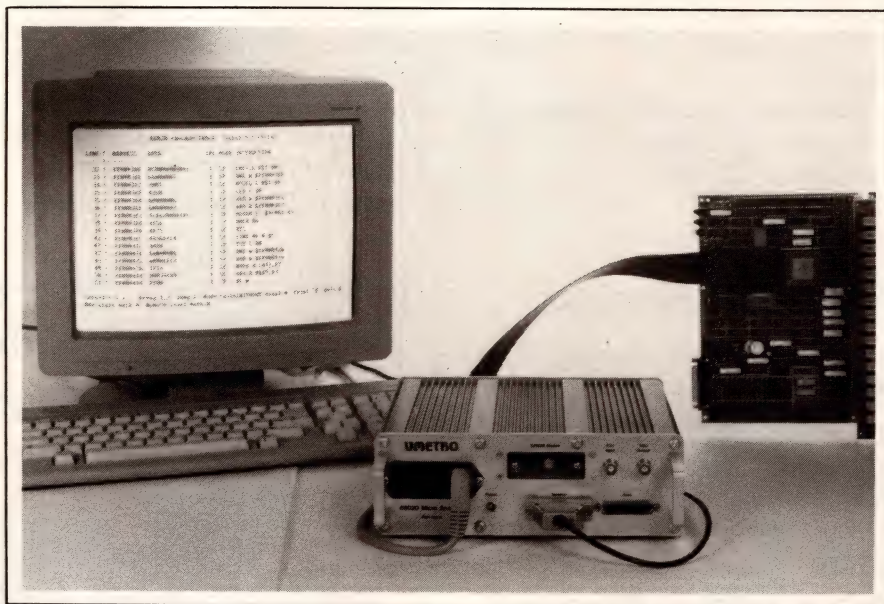
NEW PRODUCTS

TEST & MEASUREMENT INSTRUMENTS

68020 ANALYZER

- Disassembles code and traces program flow
- Measures cache hits and interrupt-level distribution

The PMA-020A microanalyzer stand-alone development tool tests, debugs, and evaluates 68020-based systems. A short cable connects it to the target μ P socket. An RS-232C port links the analyzer to an ASCII terminal to provide the operator interface. A second RS-232C port lets you use the same terminal as the operator interface for the target system. The specialized 88-channel logic/software-performance analyzer was optimized for developing and debugging modules such as drivers and operating-system kernels. The analyzer disassembles 68020 code, traces program flow, and determines the cache hit rate



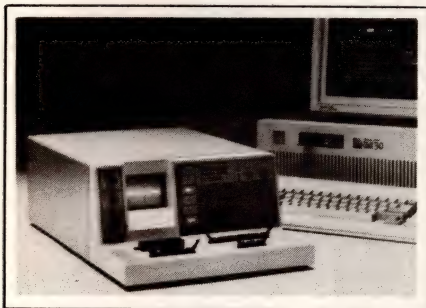
and the distribution of interrupts on the μ P's interrupt levels. \$7900.

Vmetro A/S, Sognsvn 75, N-0855 Oslo 8, Norway. Phone 47 2 39 46 90. FAX 47 2 18 39 38.

Circle No 420

Vmetro Inc, 2500 Wilcrest, Suite 530, Houston, TX 77042. Phone (713) 266-6430. FAX (713) 266-6919.

Circle No 421



TROUBLESHOOTER

- Memorizes analog signatures at good boards' circuit nodes
- Lets you compare unknown boards with good boards

The Tracker 5100DS uses analog-signature analysis to help you troubleshoot analog and digital pc boards. You employ this PC-hosted instrument to force small ac currents into circuit nodes. It measures the ac voltages that appear at the nodes, digitizes them, and stores them on disk. You can recall the signatures from disk and display as many as eight on the PC's display.

By recording the signatures from a good board and comparing the corresponding signatures from a board under test, you can find inputs with marginal-breakdown voltages, out-of-tolerance components, and gates and capacitors with high dissipation. \$9500.

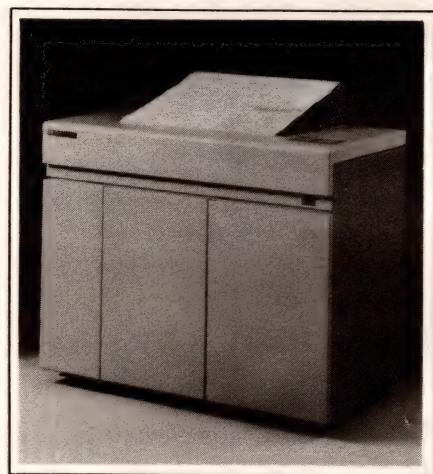
Huntron Instruments Inc, 15720 Mill Creek Blvd, Mill Creek, WA 98012. Phone (800) 426-9265; in WA, (206) 743-3171. TLX 152591.

Circle No 422

PLOTTERS

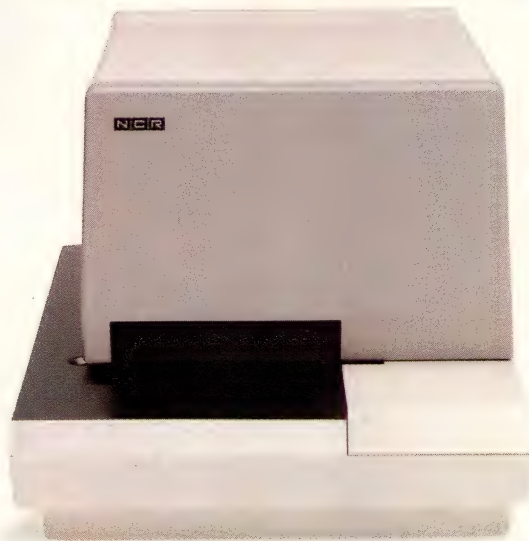
- Use electrostatic imaging to resolve 406 dots/in.
- Produce D- and E-size drawings in under 1 minute

The HP 7600 Series Models 240D and E are electrostatic plotters that produce monochrome output on D- and E-size coated paper at a rate exceeding 1 page/minute. Though the plotters' only moving parts are



the paper and the paper-drive mechanism, the plots, whose resolution is 406 dots/in., are as sharp as those produced by electromechanical pen plotters. The plotters incorporate a vector-to-raster converter and accept input in HP-GL/2, a superset of the vendor's earlier HP-GL (graphics language). Because of HP-GL/2's total compatibility with HP-GL and the wide support of HP-GL by vendors of CAD and CAE software,

One is twice as good as two.



Introducing the NCR 2208. The one, and *only* 40-column printer that has the functionality of two.

And that's twice as good because now one printer can handle just about any retail transaction. Three print modes and 90° font rotation provide horizontal receipt printing as well as horizontal and vertical slip printing. This makes the 2208 the first printer in the world that can handle both EFT and credit authorizations with equal ease.

You also get more design flexibility. The 2208 is available in either a standalone unit or as a print mechanism only. And both configurations are lightweight and offer an extremely small footprint.

And when you use one printer to do the work of two, you can reduce your inventory and

service—practically in half.

The final point of comparison—cost. Obviously buying one printer is better than buying two. It's like getting one printer free. And that gives you either better margins or more aggressive pricing on your systems.

The only thing that could make this printer better is that it's from NCR—the world's leader in POS products.

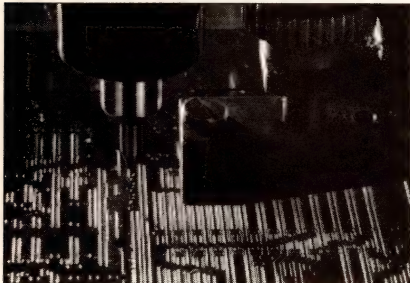
If you're looking for a way to be twice as good as the competition, call the NCR Technology Marketing Division at 1-513-445-7443 for a demonstration. The new 2208 Slip/Receipt Printer—only from NCR.



Creating value

NCR is the name and mark of NCR Corporation.
© 1988, NCR Corporation.

Now in-house prototyping is truly affordable.



Mills and drills circuits in minutes.

There's no reason to waste time and money sending out for prototype circuit boards any longer. With the new BoardMaker, you can make your own prototypes in your own lab directly from your PCB CAD—as fast as you need them.

No delays or rush charges.

BoardMaker engraves single and double-sided boards, forming conductor lines as small as 5 mil. (There is a throughplate option too.)

A 2" x 3" board with medium density, for example, takes about 15 minutes. So you can save a week or more *at every level* of design development. You also save the money spent on outside sources, along with costly charges for rush service that can't compare with BoardMaker speed.

No chemicals.

BoardMaker is totally *mechanical*. There are no chemicals, no fumes, and no toxicity problems.

At \$5,000, pays for itself fast.

BoardMaker is revolutionary because it costs *one-sixth* the price of first generation prototype machines—and literally pays for itself after about a dozen boards. For more information, call (415) 883-1717 or use the reader card.



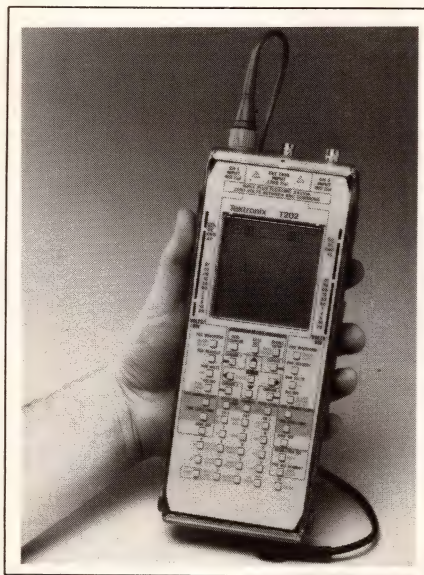
20A Pamaron Way
Novato, CA 94948

TEST & MEASUREMENT INSTRUMENTS

existing software packages already support these plotters. The vendor claims that you can simply plug in the electrostatic plotters in place of HP-GL-compatible pen plotters and start producing drawings in minutes. 24-in.-plot-width model, \$22,900; 36-in.-plot-width model, \$27,500. Delivery, four to six weeks ARO.

Hewlett-Packard Co., 19310 Pruneridge Ave, Cupertino, CA 95014. Phone local office.

Circle No 423



PLD TEST GENERATOR

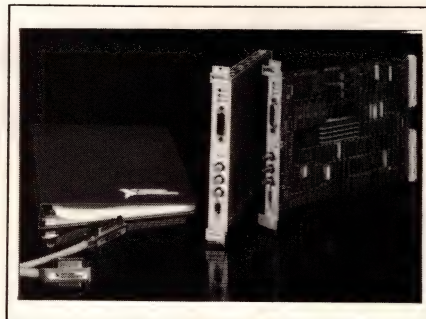
- Allows in-circuit testing of devices on pc boards
- Supports devices that you can't initialize

Version 2 of the vendor's ATG (automatic test generation) software runs under MS-DOS and creates test routines for PLDs, including those already mounted on pc boards. According to the vendor, the tests provide very-high-fault coverage during in-circuit testing where you can't preload initial conditions into devices. The software models ICs the way you actually use them—with some pins connected together or to V_{CC}. It also lets you enter information on constraints imposed by the circuitry that surrounds the device under test. The

vendor will upgrade existing installations at no charge. \$4950.

Anvil Software, 427-3 Amherst St, Suite 341, Nashua, NH 03063. Phone (603) 891-1995. TWX 910-250-3381.

Circle No 424



GPIB/VXI INTERFACE

- Plugs into VXI bus and links it to the IEEE-488 bus
- Transparently routes messages between the two buses

The GPIB-VXI circuit card plugs into the VXI bus (VME Bus extension for instrumentation). With its two backplane connectors, this "C-size" board conforms to the VXI standard. The card edge opposite the backplane supports an IEEE-488 connector; a 9-pin, D-subminiature connector used for an RS-232C port; and BNC connectors for triggering input, output, and an external clock input. A 32-bit 68070 μ P has 512k bytes of dual-ported RAM that you can increase to 4M bytes. The μ P runs under a firmware-resident version of the pSOS operating system and makes the board and all the IEEE-488 devices connected to it appear to the VXI subsystem as a VXI device with its own command set. The μ P manages the VXI bus resources; controls communication between the VXI and IEEE-488 buses; and lets you download custom instrument-control software modules. \$3000.

National Instruments Corp., 12109 Technology Blvd, Austin, TX 78727. Phone (800) 531-4742; in TX, (800) 433-3488. TLX 756737.

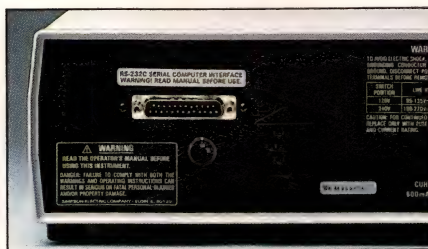
Circle No 425



THE SIMPSON 560 MENU DRIVEN MULTIMETER. SOMETHING NEW ON THE MENU.

From microvolt transducer measurements to high voltage work, Simpson's new *Professional Series Model 560 Digital Multimeter* is designed to quickly give the answers you need—without elaborate signal conditioning.

Diagnostic functions such as MIN/MAX Hold and Peak Hold let you find and display transient amplitudes, while the bar graph continues to monitor the incoming signal. Programmable data logging on any range or function and a built-in 500 KHz frequency



counter, further expand the acquisition capabilities of the Simpson 560.

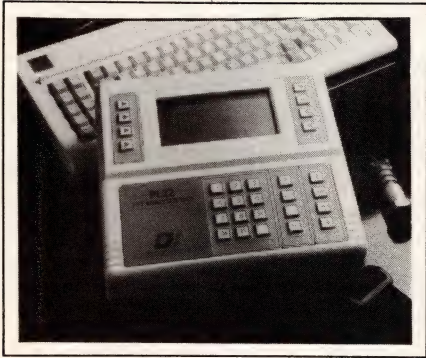
What's more, it's now possible to speed up routine tests—saving only the measurements of interest—because the 560 offers real-

time comparison to stored test limits. Permanent records of the captured data can be generated by computers or printers connected to the optional interfaces (Centronics, RS-232 or IEEE-488). Displayed menus make it quick and easy to set the measurement parameters. And ultra-fast autoranging inputs instantly calculate the proper scale.

Order from our menu. The Simpson 560 Menu Driven DMM. You'll agree that it's done quite tastefully.

Simpson Professional Series products are made in USA.

SIMPSON



FFT ANALYZER

- Has a bandwidth of 20 kHz
- Is battery powered and portable

Weighing 4 kg and measuring 256×250×82 mm, the battery-powered PL21 single-channel and PL22 dual-channel FFT analyzers are suitable for a variety of field and lab test applications in mechanical, structural, acoustic, and electrical engineering. The instruments analyze frequencies in the range of 0 to 20 kHz and produce frequency spec-

trums with as many as 1600 lines and a resolution as high as 62.5 mHz. They have input voltage ranges between ± 5 mV and ± 5 V, which you can autorange or manually range in a 1-2-5 sequence. An accelerometer input allows you to connect the instrument to accelerometers with built-in charge amplifiers without a separate accelerometer power supply. Eight input frequency ranges, between 100 Hz and 20 kHz are provided, and the analyzers have a data record length selectable between 256 and 4096 points. Triggering facilities allow pre- and post-trigger recording. The instruments have 256k bytes of nonvolatile memory in which you can store as many as 250 measurements. Signal-processing functions include autospectrum, cross-spectrum, autocorrelation, cross-correlation, transfer function, coherence, and averaging functions. You can dump measured data through the

RS-232C interface. PL21 \$5900; PL22 \$8900.

Diagnostic Instruments Ltd, 264 W Main St, Murraysgate Industrial Estate, Whitburn, West Lothian EH47 0LB, UK. Phone (0501) 43031. FAX (0501) 43933.

Circle No 426

PS/2 I/O CARDS

- Plug into Micro-Channel bus
- Provide analog and digital I/O capability

The MC-MIO-16 is an analog, digital, and timing I/O board for the IBM PS/2 Micro-Channel bus. The MC-DIO-32F is a 32-bit parallel digital I/O interface card for the same bus. It achieves high speed by implementing DMA. The MC-DIO-24 is a lower-cost and lower-speed 24-bit parallel digital I/O card for interrupt-driven applications. The MC-MIO-16 incorporates a 12-bit A/D

Hermetically Sealed!

For Industrial and Military Applications

High Performance Keylock Rotary Switches Compact, Versatile, Reliable, Rugged, Safe!

- High precision and reliability
- Short depth, rugged construction, 8 tumbler safety lock
- MIL qualified and industrial rotary switches
- Standard lock, sealed or cap-protected hermetically sealed version for severe ambient conditions
- Almost unlimited combination possibilities with respect to number of decks, poles per deck, angle of throw, key removal positions, spring return contacts. BCD coding available too
- Bright chromium plated finish is standard, options are black, Nato green and matt chromium plated
- Systems with master key, central lock or authorized key positions available



Standard and Hermetically Sealed Keylock Rotary Switches

For further information on these excellent keylock rotary switches call or write to DATA MODUL GmbH, Landsberger Straße 320, D-8000 München 21, West Germany, Telex 5213118, Fax 89 - 560 17 119, Tel. 89 - 560 17 0

DATA MODUL

GmbH

CIRCLE NO 197

The Complete UNIX/Real-Time Connection.



OS-9 utilizes common UNIX features:

- Multi-user, Multi-tasking
- UNIX I/O model
- UNIX task model:
(fork, set priority,...)
- Pipes and Signals
- Shell User Interface
- Hierarchical Disk File System

...and more to connect you to Real-Time:

- Fast task switching
- Data modules
- Easy system generation and reconfiguration
- Fast interrupt servicing
- Events and semaphores
- Resident OS-9 compilers, assemblers and debuggers

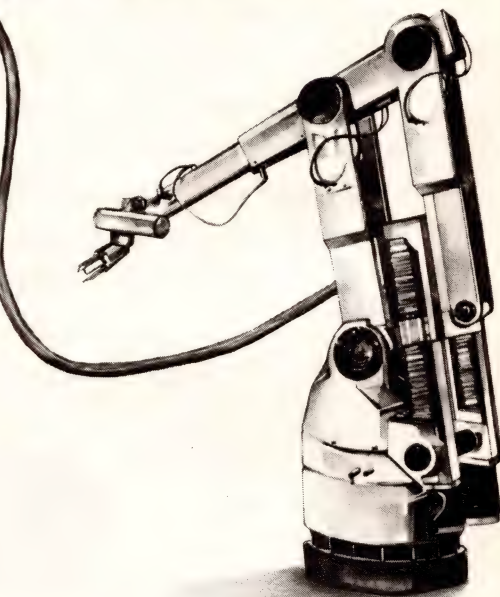
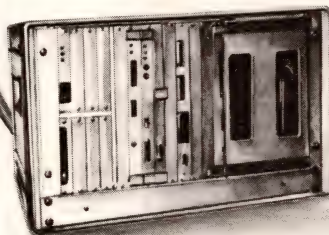
OS-9 UniBridge

Integrating UNIX and C applications into VMEbus systems has just been made easier with Microware's introduction of UniBridge. UniBridge is a complete development and communications package that allows you to connect your SUN 3, DEC VAX, HP 9000 or Motorola Delta workstation, to the world's premier real-time operating system: OS-9.

UniBridge provides a gateway so you can utilize UNIX in every phase of VMEbus system integration. From hosting C application development to monitoring large real-time networks, UniBridge connects UNIX to your OS-9 target system; whether it's ROM-based, disk-based, networked or stand alone.

UniBridge contains three high performance software modules that link UNIX and OS-9:

- OS-9/XCC Cross C Compiler allows you to produce compact, re-entrant and position independent C applications on your workstation for high speed execution on your OS-9 target.
- OS-9/ESP Ethernet Support Package provides industry standard BSD 4.2 sockets for TCP/IP communications with full FTP and Telnet support. UniBridge lets your workstation become a real-time server.
- OS-9/SRCDBG debugs resident VMEbus applications at the C source level, all interactively, across the Ethernet network from your UNIX terminal. And UniBridge makes all file access and transfer transparent from system to system while you debug.



And no other operating system complements UNIX with real-time functionality better than OS-9. OS-9, like UNIX, is a complete operating system to provide extensive C and math libraries, independent file managers, inter-process communications, debuggers and resident compilers. Yet OS-9 is 100% ROM-able and executes in real-time to host thousands of imaging, process control, data acquisition, communications and robotics projects worldwide.

Best of all, every module of UniBridge and OS-9 is written entirely by Microware to provide you one source for technical support and service.

From UNIX and C, to OS-9 and VME, contact Microware today and let your next real-time application shine with UniBridge: The Complete UNIX/Real-Time Connection.

OS-9 and UniBridge are trademarks of Microware Systems Corporation.
VAX and VMS are trademarks of Digital Equipment Corporation. UNIX is a trademark of Bell Laboratories. Sun is a trademark of Sun Microsystems, Inc.

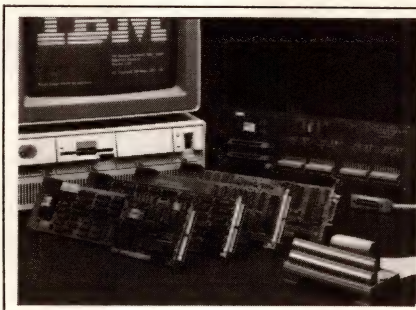
microware® **OS-9**

Microware Systems Corporation
1900 N.W. 114th Street
Des Moines, IA 50322
Phone: 515-224-1929

Microware Western Regional Office — Santa Clara, CA 408/980-0201;
Microware Japan 0474 (22) 1747

Distributors: West Germany 06221-862091; France (1) 43-33-96-38; Italy (6) 762221;
Switzerland (056) 83-3377; Sweden (018) 138595; Australia (02) 919-4917

converter preceded by an amplifier that provides software-controlled gain and an analog multiplexer with 16 single-ended inputs. The board also contains a pair of 12-bit D/A converters with double-buffered digital inputs, eight TTL-compatible digital I/O lines, and three 16-bit counter/timer channels. Other features include a FIFO buffer for A/D



conversion results, an automatic channel sequencer for the analog multiplexer, and a timer and interrupt generator. You can obtain the board in three A/D-conversion speed grades: 9, 15, and 25 μsec /conversion. The fastest grade permits a throughput of 100k conversions/sec. MC-MIO-16, from \$1195. MC-DIO-24, \$245. MC-DIO-32F, \$595.

National Instruments Corp., 12109 Technology Blvd, Austin, TX 78727. Phone (800) 531-4742; in TX (800) 433-3488. TLX 756737.

Circle No 427

Your Logic Analyzer Really Needs The PI-6500 Pattern Generator.

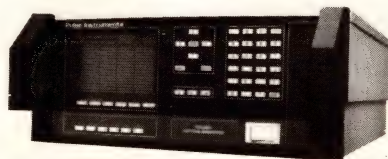
Here's Why:

1. The new Pulse Instruments PI-6500 Pattern Generator and your Logic Analyzer are a cost effective alternative to high-priced test systems.
2. Working together they offer you general-purpose digital signal send-receive capability.
3. You won't have to kluge digital signals or build special circuits any more — the PI-6500 Pattern Generator and your Logic Analyzer will do it for you.
4. You can now create interactive functions between the DUT, PI-6500 Pattern Generator and your Logic Analyzer.
5. You can make R&D or one of a kind test set-ups quickly and easily.
6. You can simplify digital test systems with this "off the shelf" Pattern Generator.
7. The PI-6500 Pattern Generator allows you to test at speeds up to 25 MHz.
8. You can compare actual and expected test results.
9. You can simulate any digital input signal complete with interactive control.
10. You can create complex serial and parallel digital data streams for any application.

The PI-6500 Pattern Generator features specs like: 16 to 112 Channels, 256 Trigger/Flag Combinations, Easy Programming, Serial/Parallel Modes. And it is ideally suited to large digital test systems and military applications.

Want more information?
Call Pulse today at:

(213) 515-5330.



Pulse Instruments PI-6500 Pattern Generator.

Pulse Instruments

1234 Francisco Street • Torrance, California 90502 • (213) 515-5330



BOARD TESTER

- Performs time-phased analog and digital generation
- Can sample at equivalent of 1 GHz

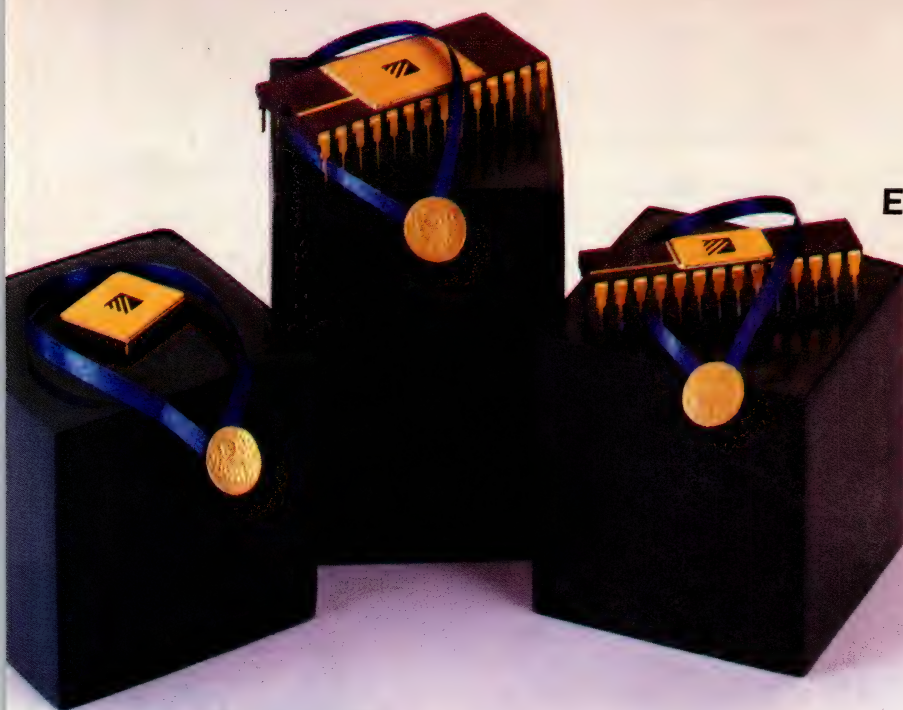
The Expertest 2000 automatic test system is hosted by an 80386-based PC. The system tests loaded pc boards. It runs the vendor's diagnostic expert system software and uses a bed-of-nails fixture. The unit generates coordinated, time-phased, analog and digital patterns. Its high-speed channels can sample continuously at 200 MHz or can achieve an effective 1-GHz sample rate on repetitive waveforms by programmable edge shifting. According to the vendor, you don't have to write any code. The artificial-intelligence-based test-generation software tests with 1000 channels and, the vendor maintains,

MILITARY 256K RACE

EDI—First from the Start

Since 1983, when EDI introduced the first Military 64K SRAM, the company has been first in the race to market with the latest generation, highest density, CMOS MIL-STD 883 devices.

With a new family of fast 256K Monolithics, DESC qualified devices, and a new JEDEC standard Megabit Module, EDI is maintaining its' leadership position with the widest array of Military CMOS Static RAMs available today.



EDI's 256K Gold Medalists

256Kx1	35, 45, 55ns
64Kx4	35, 45, 55ns
32Kx8	45, 55, 60ns

And, all are available in a variety of ceramic, JEDEC standard DIP and LCC Packages.

 **EDI**
The future... today.

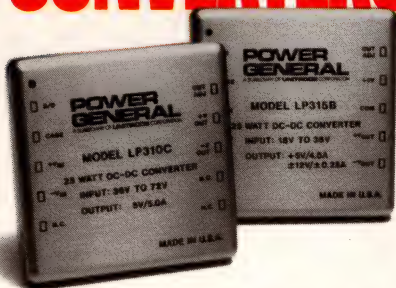
Electronic Designs Incorporated

Corporate Headquarters: 42 South Street, Hopkinton, MA 01748 USA (617) 435-2341, TFX: (617) 4356302, TLX: 948004

Electronic Designs Europe Ltd.,

Shelley House, The Avenue, Lightwater, Surrey GU18 5RF United Kingdom, 0276 72637, TFX: 0276 73748, TLX: 858325

ULTRA LOW PROFILE WIDE INPUT 25W, DC/DC CONVERTERS



Got an "on card" power distribution problem? Not enough real estate for a big modular supply? Don't want to use two card slots for any of the readily available "high profile" converters?

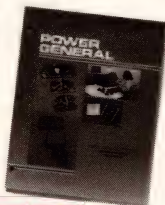
Well, Power General has the LP-310/315 solution. These compact converters utilize surface mount manufacturing, high frequency design and unique thermal management techniques to achieve performance features such as:

- 0.375 inch height
- 25 watts output power
- > 500,000 hour MTBF
- 2:1 input range
- 500 VDC input/output isolation
- Industry standard Pin-out
- Full five year warranty

Power General, utilizing the latest technology to provide complete, innovative solutions to your power needs.

FREE HANDBOOK!
Call for your free
1988 Power Supply
Handbook

**Put
Power General
To Work For You!**



POWER GENERAL

A SUBSIDIARY OF **UNITRODE** CORPORATION
152 Will Drive, P.O. Box 189, Canton, MA 02021
(617) 828-6216 TWX: 710-348-0200
FAX: 617-828-3215

INSTRUMENTS

thousands of diagnostic messages. From \$17,985 to \$49,985. Delivery, 30 to 45 days ARO.

Array Analysis, 200 Langmuir Lab, Brown Rd, Ithaca, NY 14850. Phone (607) 257-6800. TWX 490-000-1912.

Circle No 428

TEST GENERATOR

- Generates device- and board-test programs
- Uses waveform database derived from simulator output

The VectorBridge software package produces device- and board-test programs. It uses files generated by logic-simulation programs in the vendor's standard-events format. The test programs created comply with restrictions imposed by the target tester's hardware. The software's programs are compatible with Hewlett-Packard's 3065 and 16500, Integrated Measurement Systems' Logic Master, and Schlumberger and Semiconductor Test Solutions' systems that use the Factor language. The package runs on workstation platforms that support the vendor's other software products. Starts at \$10,000 for upgrades; \$15,000 for new installations.

Test Systems Strategies Inc., 8205 SW Creekside Pl, Beaverton, OR 97005. Phone (503) 643-9281.

Circle No 429

5-DIGIT DMM

- Incorporates 52-segment bar-graph display
- Includes 500-kHz frequency counter

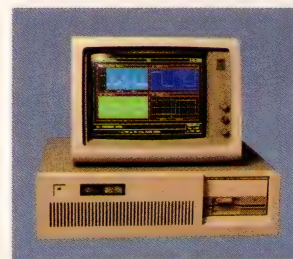
The model 560 digital multimeter makes dc-voltage measurements with a basic uncertainty of 0.0035%. It measures dc voltage from 10 μ V to 1 kV, ac voltage from 10 μ V to 750V, resistance from 10 m Ω to 50 M Ω , dc and ac current from 10 nA to 10A, and frequency from 5 Hz to 500

DADiSP..

Let Your Instruments
Do The Talking.™



Talk to your instruments with **DADiSP-488**. Use over 150 functions to display and analyze your waveforms, as easy as typing a name. Run external data acquisition software, or *your own analysis programs*. Create new functions with **DADiSP Macros**.

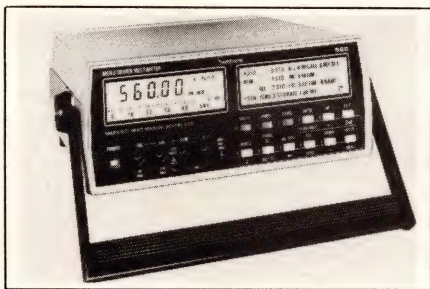


the First Spreadsheet
designed exclusively for
Scientists and Engineers.

(617) 577-1133

Order our \$20 Interactive Demo Disk. Ask about DADiSP for IBM-PC/XT/AT, DEC MicroVAX, HP9000, Masscomp 5000, and Sun Workstations. For further information write DSP Development Corporation, One Kendall Square, Cambridge, MA 02139, (617) 577-1133





kHz. It can also compute voltage ratios in dBm and power ratios in dBW, determine diode function, and provide both an audible and visual indication of continuity during go/no-go testing. The unit sports a pair of LCDs. One provides both numeric and 52-segment bar-graph readouts. You use the other, an alphanumeric panel, to display menus during programming of the instrument. \$2195; with RS-232C or Centronics interface, \$2395.

Simpson Electric Co., 853 Dundee Ave, Elgin, IL 60120. Phone (312) 697-2260. TLX 722416.

Circle No 430

ELECTRONIC LOADS

- *Impose static and dynamic loads to 2 kW*
- *Sink 300A and can withstand 150V*

The Autoload Series of electronic loads checks for overvoltage, overcurrent, overpower, overtemperature, and reverse-polarity conditions. The line includes models that can continuously absorb a maximum power of 0.5, 1, and 2 kW. The 2-kW model sinks 300A. When sinking 150A or the maximum-specified current, whichever is smaller, the units operate normally at 3V min. The loads behave as programmable, constant or time-varying, multirange resistances or current sinks. A remote-sensed, 12-bit measuring system withstands 150V max. The loads are ohmically isolated from the chassis and from their IEEE-488 interfaces. You can connect either of the loads' terminals to the

ground. When you use the units as time-varying loads, you can control the low- and high-current levels, the duty factor, the slew rate, and the frequency. The units can store five programmed waveforms and can rapidly switch between any pair. From \$6250.

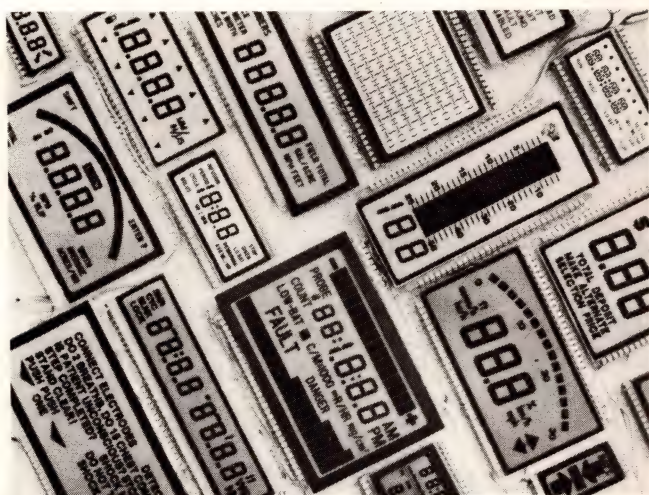
Analogic/3H, 1289 Hammerwood Ave, Sunnyvale, CA 94089. Phone (408) 734-5970. FAX 408-734-5139.

Circle No 431

SIGNAL ANALYZER

- *Performs spectrum analysis from dc to 102.4 kHz*
- *Performs network analysis from dc to 51.2 kHz*

The HP 35660A FFT-based low-frequency spectrum/network analyzer performs spectrum analysis from dc to 102.4 kHz and network analysis from dc to 51.2 kHz. Its 3½-in. disk drive can load signal-analysis pro-



At LX Design, we will custom-tailor a display that says exactly what you want. Artwork is relatively inexpensive. Use your creativity without incurring a cost penalty. With our array process, LX Design is producing large area, long life displays to quality standards that are the best in the industry.

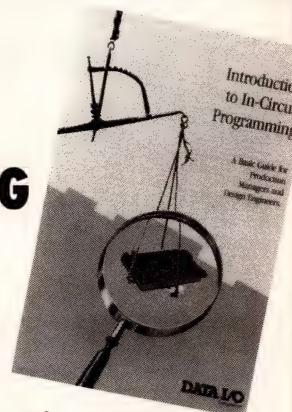
Find out more about our custom display capabilities. Write

LX Design, Inc.

24500 Highpoint Road
Beachwood, Ohio, 44122
or call (216) 292-3300.

CIRCLE NO 203

DESIGN FOR IN-CIRCUIT PROGRAMMING AND CUT PRODUCTION COSTS.



Following a few simple rules in board design can mean tremendous savings in production. When you design for in-circuit programming, you can easily program devices on your circuit boards after they are fully assembled.

In-circuit programming can improve production flow, reduce inventory, and lower firmware update costs—especially

for surface-mount devices. And Data I/O's complete line of in-circuit programmers are the most reliable, versatile and cost-effective tools for the job.

**CALL TODAY FOR
YOUR FREE COPY OF
"INTRODUCTION TO
IN-CIRCUIT
PROGRAMMING."**

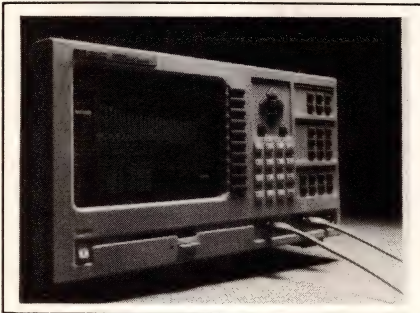
1-800-247-5700

Ext. 951

DATA I/O

CIRCLE NO 204

grams developed by third parties into the internal computer. These programs utilize the vendor's disk-based HP 35680A Instrument Basic language interpreter; they customize the analyzer for specialized applications such as diagnosis of electric-motor problems from vibration spectra. You can write your own programs in Instrument Basic and

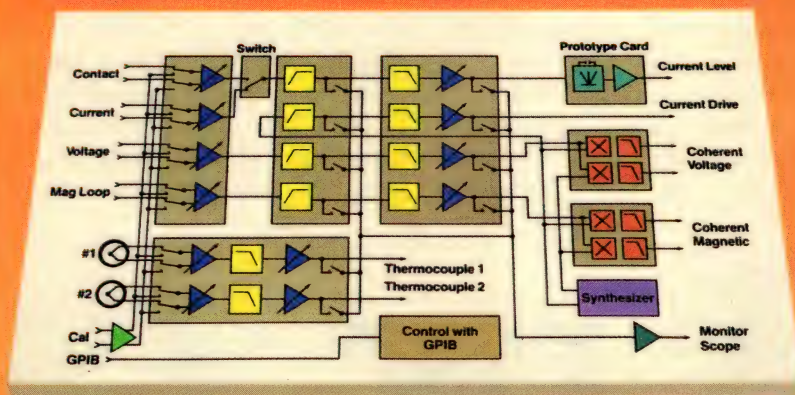


develop them on an MS-DOS-based PC. Using an ASCII keyboard, you can type in your programs, or you can enter them from the analyzer's front panel by keystroke recording of Basic keywords. HP 35660A, \$12,500; HP 35680A, \$500. Delivery, eight weeks ARO.

Hewlett-Packard Co., 19310 Pruneridge Ave, Cupertino, CA 95014. Phone local office.

Circle No 432

CUSTOM SYSTEMS/STANDARD HARDWARE



**Thermocouple
filter/amps.**

**Acoustic
preamp/filters.**

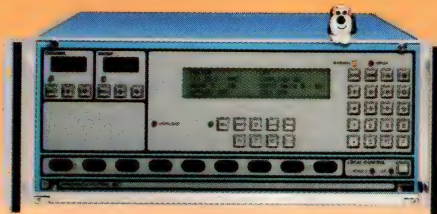
**Synchronous detection
of voltage & mag
signals.**

**Prototype card
for custom circuits.
Signal switching
module.**

**Computer control.
Signal Monitor & Cal.**

Only With System Friendly

This custom system measures deuterium in a nuclear fuel transport pipe. Just one of hundreds of custom systems now in service using standard Precision 6000 hardware. What can we customize for you? Call (607) 277-3550 for brochure. Or write.



PRECISION FILTERS, INC.

240 Cherry Street, Ithaca, New York 14850

CIRCLE NO 205



IN-CIRCUIT EMULATOR

- Supports 80C196, 8096-90, and 8096-BH μ Ps
- Shares memory with host PC at 12 MHz max

The EMS96 in-circuit emulator supports the 8096-90 and 8096-BH microcontrollers. It allows multiple hardware breakpoints on instruction fetch, data read, write, address or pattern matching. The emulator plugs into the IBM PC bus and provides full-speed emulation. You place the 8096 code and data in the PC's memory, where both the PC and the 8096 can share it. The emulator maps this RAM space to shared or user memory in 64-byte blocks. It allows your PC-resident programs to access, display, and modify variables without affecting the microcontroller's operating speed. The unit supports the host processor's speeds from 4.77 to 12 MHz and the 8096's speeds from 3 to 18 MHz. It allows for symbolic debugging in ASM96, PL/M96 and C96. \$2995.

Annapolis Micro Systems Inc., 612 3rd St, Suite 301, Annapolis, MD 21043. Phone (301) 269-8096.

Circle No 433

DESIGNED TO TAKE ON THE WORLD'S TOUGHEST ASSIGNMENTS.

Mallory designs and
manufactures a broad line

of high-reliability, wet
tantalum capacitors to meet
your specific design needs.

The CLR-79 and CLR-81
hermetically sealed, all
tantalum wet slug
capacitors meet MIL-39006
requirements with low DC
leakage, low ESR, high
ripple current ratings and
3 volts reverse voltage
capability. These high and
extended range capacitors
maintain quality approval
up to failure levels R (CLR-
79) and P (CLR-81).

For your next
assignment, go with
the leader. Contact
your local authorized
Mallory distributor or
Mallory today.
Mallory Capacitor.

Stronger Than Ever.



WET SLUG TANTALUMS

Style	Mil Spec (or description)	Mallory Type
CLR-79	M39006/22	TLT
CLR-81	M39006/25	W18
CLR-65	M39006/09	TLX
CLR-69	M39006/21	TXX
CLR-10/14/17	Mil-C-39006/18/19/20	XT
CRL-01/02	Mil-C-83500	W13
	Silver Tubular	MTPH
	All Tantalum Module	TMX



Mallory Capacitor Company
4760 Kentucky Avenue
P O Box 1284
Indianapolis Indiana 46206
Telephone 317 856 3731



EMHART MALLORY

Get your custom Power Assembly with all the trimmings, from KEPCO, your power supplier.™

We'll help you create a custom power assembly professionally constructed and wired and tested to your specific system requirements. With Kepco's selection of digital voltmeters and ammeters, LEDs, test points, trimmers, circuit breakers and switches, you can create a multi-output power assembly with just the control and monitoring facilities you need. Kepco offers a large assortment of rear-panel options, too: a-c and d-c inlets, barrier strips and heavy duty connectors for high current service. If you like, we can even incorporate custom connectors of your choice.

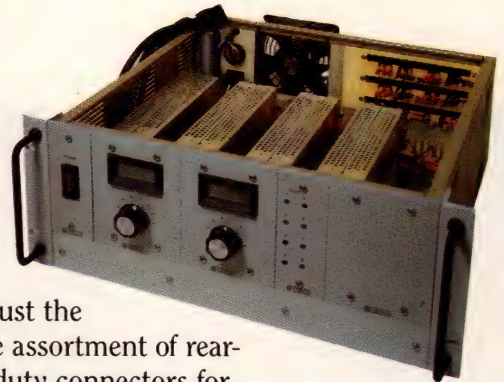
All at surprisingly low cost.

Our expert engineers will work with you to layout a custom assembly to your specifications choosing from power modules that span 3 Watts to 1500 Watts, 2 Volts to 48 Volts —

a-c and d-c inputs. An easy-to-use template and layout grid system enables you to determine what combination can be fit into our five (5) basic housings that range 16" to 24" deep, 5¼" or 7" high in a standard 19" configuration.

Let us send you a colorful 6-page brochure that tells you a lot more. It lists suggested power modules with prices that allow you to estimate cost on the spot.

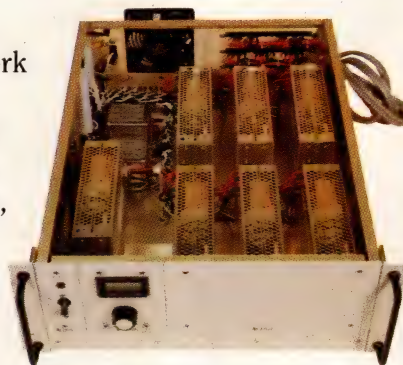
These photos illustrate custom power assemblies showing the variety of front and rear layouts chosen by our customers.



TYPICAL ASSEMBLY

OUTPUTS

+ 28 VOLTS & 2.15 AMPS
+ 28 VOLTS & 2.15 AMPS
- 28 VOLTS & 2.15 AMPS
- 28 VOLTS & 2.15 AMPS
± 15 VOLTS & 0.4 AMPS
± 15 VOLTS & 0.4 AMPS



TYPICAL ASSEMBLY

OUTPUTS

+ 5 VOLTS & 24 AMPS
+ 5 VOLTS & 6 AMPS
+ 5 VOLTS & 6 AMPS
- 5 VOLTS & 6 AMPS
- 2.1* VOLTS & 0.25 AMPS

*Modified Standard Unit

TYPICAL ASSEMBLY

OUTPUTS

+ 5 VOLTS & 10 AMPS
+ 5 VOLTS & 10 AMPS
- 5 VOLTS & 10 AMPS
- 5 VOLTS & 10 AMPS
+ 28 VOLTS & 2.15 AMPS
- 28 VOLTS & 2.15 AMPS



TYPICAL ASSEMBLY

OUTPUTS

+ 24 VOLTS & 10 AMPS
- 24 VOLTS & 10 AMPS
+ 5 VOLTS & 48 AMPS
+ 12 VOLTS & 10 AMPS

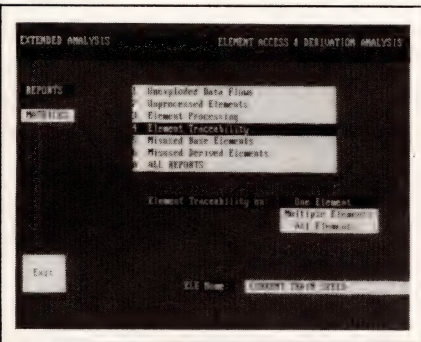


Can we create one for you? Call or write
Dept. LBF-12, KEPCO, INC., 131-38 Sanford Avenue,
Flushing, NY 11352 USA • (718) 461-7000
TWX #710 582 2631 • FAX (718) 767-1102.



NEW PRODUCTS

CAE & SOFTWARE DEVELOPMENT TOOLS



CASE TOOL

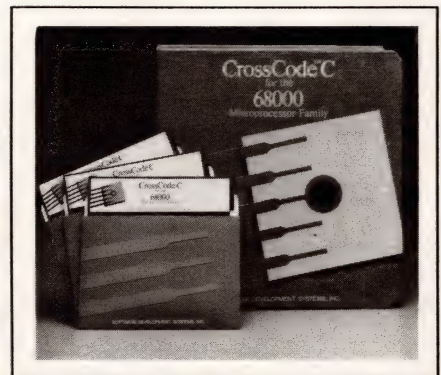
- Analysis and workbench tools for real-time systems
- Semantic and syntactic validation of specifications

Exceleator/RTS version 1.8A software lets you develop specifications for embedded and real-time systems. It works with the IBM PC/XT, PC/AT, PS/2, and compatibles. The software supports the

Ward-Mellor and Hatley techniques for system design. You can adapt graphics and a central dictionary using the vendor's customizing software. The software provides semantic and syntactic validation of specifications. Its new features include 33 analysis reports with 25 matrices that let you check system design. An element-trace report lets you find logic errors in the design. The software's graphical-analysis facilities match your system design against 50 specified rules. \$8400. If you own a prior version of the software and have a warranty or maintenance plan, the upgrade is free; the upgrade is available to other users for \$500.

Index Technology Co., 1 Main St., Cambridge, MA 02142. Phone (617) 494-8200. TWX 910-380-7014.

Circle No 435



C COMPILER

- Generates ROMable code for the 68000 μ P family
- Can split output code into five memory sections

The CrossCode C compiler generates ROMable code for the 68000 μ P family and conforms to the ANSI C standard. The compiler package comprises a macro assembler, a

Series CV Compact Economy Switchers



Compare to LH Series TMF I

More power! Better specs! Better prices!

- Safety & EMI
- Form & function equal
- 2 year warranty
- Direct from stock
- 42 models
- 1-5 outputs
- 5-48V, to 120A

Now for a limited time – purchase small quantities @ 100 piece price!

Call Toll Free 1-800-523-2332

Deltron Inc. P.O. BOX 1369 ■ WISSAHICKON AVENUE, NORTH WALES, PA 19454
PHONE: 215/699-9261 TWX: 510/661-8061

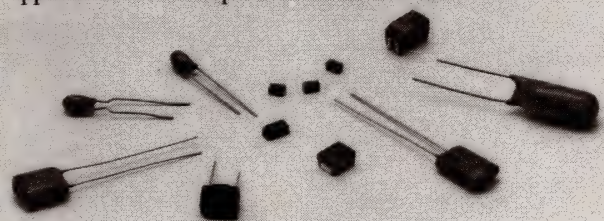
QUALITY TANTALUM CAPACITORS RELIABILITY

When your design calls for performance, you can rely on tantalum capacitors from Matsuo — where "Quality First" has always been our motto.

Matsuo tantalum capacitors give you high reliability and superior design. Twelve different types of capacitors with over 50 case sizes to meet your application needs. Emphasis is

placed on highly reliable radial lead dipped and chip tantalum capacitors. Also available are subminiatures, and molded & dip versions of polyester & polypropylene film types.

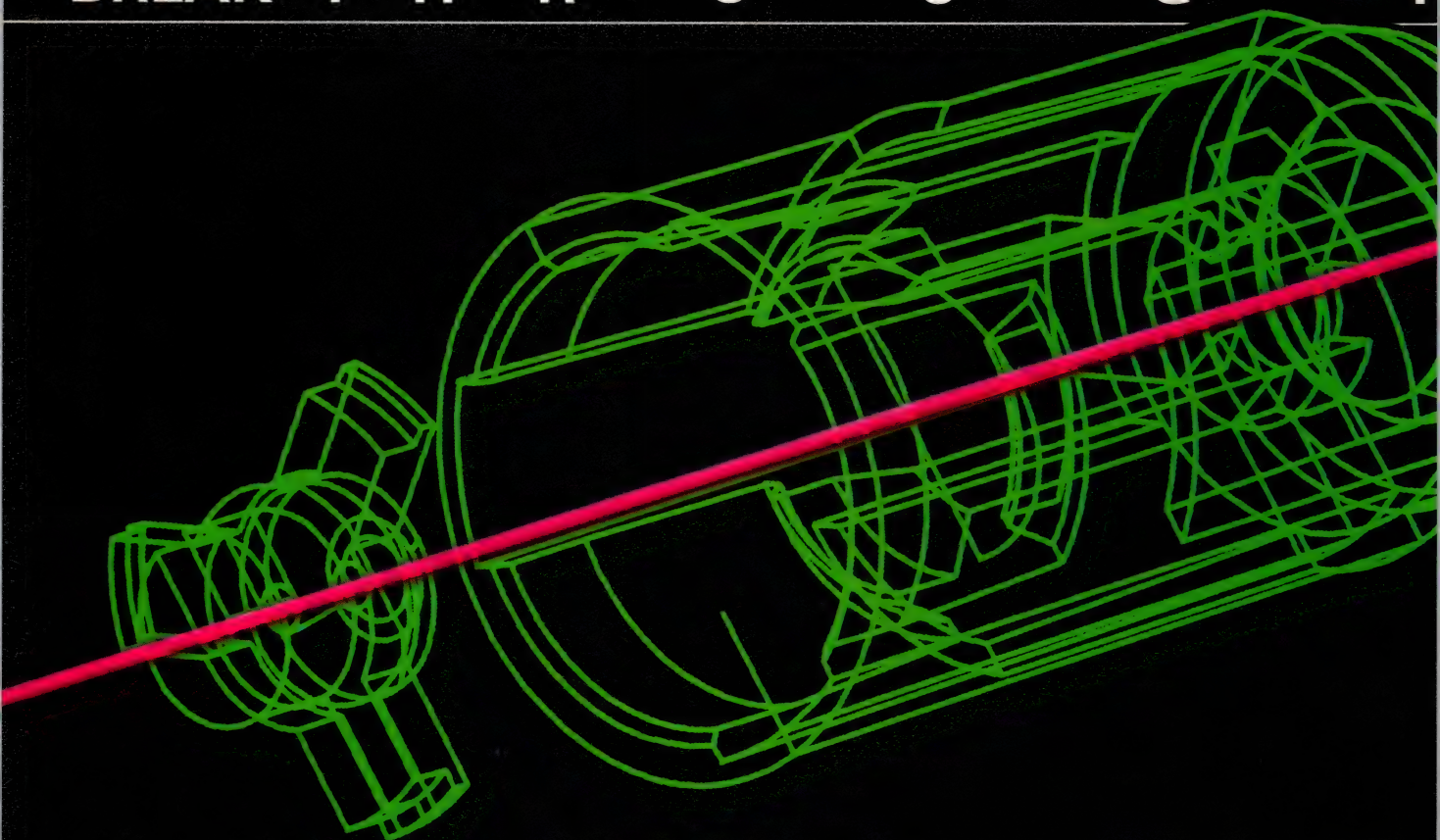
What's more, Matsuo offers very competitive prices and fills most orders from stock. Call or write today for samples, prices and literature.



©MATSUO ELECTRONICS

2134 Main St., Suite 200,
Huntington Beach, CA 92648 TEL (714) 969-2491
FAX (714) 960-6492 TWX (910) 596-1828

BREAK T H R O U G H



**New microlasers
are expanding
and refining laser
applications
through advanced
diode-pumped,
solid-state
technology.**

Amoco Laser Company's microlaser technology represents a quantum leap forward for laser light sources. Finally, a low noise, highly efficient, compact laser is available with operating voltage and lifetime characteristics that make microlasers a practical solution for many applications.

Consider the following line of infrared microlasers. They are available for immediate shipment for a wide range of uses in testing and inspection, optical alignment, materials characterizations, metrology, process monitoring,

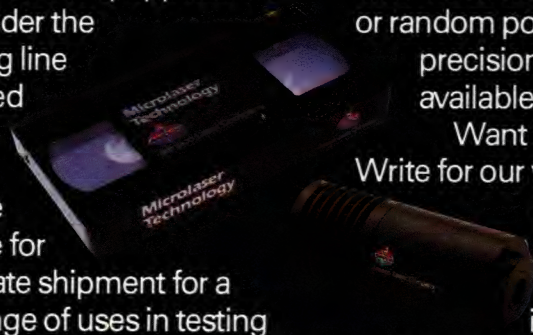
spectroscopy, micromachining, and microsurgery.

Product	Wavelength	Power
ALC1064-50	1064nm	50mw
ALC1064-150	1064nm	150mw
ALC1320-25	1320nm	25mw
ALC1320-75	1320nm	75mw

All of the above lasers have a diffraction limited, TEM₀₀ mode and are offered with linear or random polarization. A line of precision collimators is also available.

Want to learn more?
Write for our videotape which more thoroughly explains Amoco's microlaser and its uses.

Amoco Laser Company,
1809 Mill St., Naperville, IL
60540, or phone: 312-369-4190.



Amoco Laser Company

CIRCLE NO 210

CAE & SOFTWARE DEVELOPMENT TOOLS

linker, and a C library. Using the compiler, you can split output code into five RAM or ROM sections and define integer and pointer sizes over a 16- to 32-bit range. The linker lets you partition and allocate the required memory. The compiler's C library provides the source for more than 47 functions. The package also features a downloading utility that communicates with EPROM programmers, allowing you to convert compiled code into Motorola S records and other file formats. This utility also allows you to create binary images. The compiler lets you use a maximum of 64 characters for symbol names. MS-DOS or Xenix version, \$1595; Unix version, \$4795.

Software Development Systems Inc., 3110 Woodcreek Dr, Downers Grove, IL 60515. Phone (800) 448-7733; in IL or outside USA, (312) 971-8170. FAX 312-971-8513.

Circle No 436

that runs the algorithm. A screen editor displays conventional and enhanced relay-ladder symbols that you can select and enter with single keystrokes. You can at any time access an on-line help screen. The editor allows you to perform forward and backward searches for rungs, and you can delete or insert rungs. You can monitor, and even modify, a running program. The software also provides password-security protection. The enhancements include the ability to program the logic equivalent of as many as 32 16x16 stepper drums; each drum can step 16 times and selectively open or close as many as 16 contacts at each step. \$995.

Burr-Brown, 1141 W Grant Rd, #131, Tucson, AZ 85705. Phone (602) 746-1111.

Circle No 437

FORTRAN FOR 80386

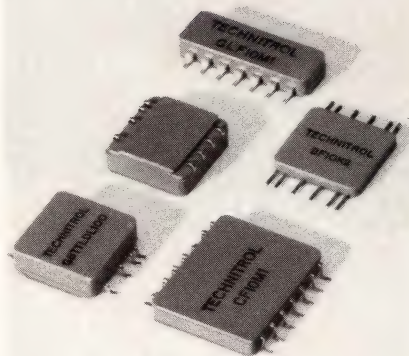
- *Makes full use of 32-bit architecture for speed*
- *Lets you compile programs as large as 4G bytes*

The F77L-EM/32 full implementation of the ANSI Fortran 77 standard includes a number of popular extensions, which makes it easier to adapt minicomputer and mainframe applications to the 80386 architecture. The compiler can use both 80287 and 80387 math coprocessors, and a future release will also work with the Weitek 1167; it will run in protected mode. The package comes with a source-level debugger, a library manager, and a 32-bit linker. To run the compiler, you need an 80386-based machine, PC-DOS 3.0 or higher, at least a 1M-byte extended memory, and either OS/386 or Developers' Kit OS/386—the two DOS-extender systems from AI Architects (Cambridge, MA). \$895.

Lahey Computer Systems Inc., Box 6091, Incline Village, NV 89450. Phone (702) 831-8123. TWX 910-240-1256.

Circle No 438

Mil-quality SURFACE- MOUNT delay lines and pulse transformers.



Believe it. Surface-mount delay lines and pulse transformers can perform the same as high-performance SIP and DIP models—provided they're from Technitrol.

Long before today's scramble to introduce surface-mount components, Technitrol commercial, military, and military-high-rel chip-carrier delay lines and pulse transformers were saving space while solving circuit-timing and data-interface problems.

Passive or active (TTL-family) delay lines, 10 to 200 ns maximum delays, five- and ten-tap modules, profiles as low as 0.080 in. Pulse transformers for Mil-Std 1553B, 2.5 Mb/s LAN, and IEEE 802.3 applications.

Request Catalogs #140 and #141.

New, rugged hermetic packages.

Now you can get excellent Technitrol performance also in hermetic surface-mount packages; your choice of alloy; plated or unplated; 100% testing available.

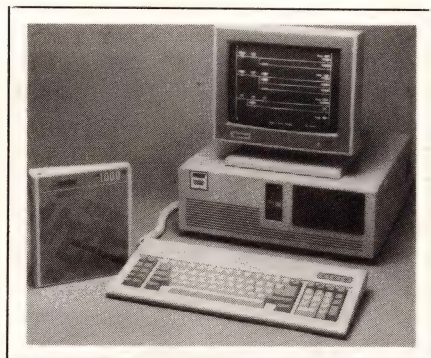


Technitrol

1952 E. Allegheny Avenue
Philadelphia, PA 19134 USA
(215) 426-9105 • Telex 834245

active and passive delay lines
• pulse transformers • Manchester
encoder/decoders • data bus couplers
• pulse-width regulators • high voltage,
Scott T, and ferroresonant transformers
(including Mil-T-21038, Mil-Std-1553B,
and Mil-T-27 components)

CIRCLE NO 211



SOFTWARE PACKAGE

- *Lets you design and run process-control functions*
- *Includes PLD and stepper-drum functions*

The PCI-20073S-1 software package is an enhanced version of the industry-standard RD1000/PC relay-ladder software. In conjunction with the vendor's PCI-20000 data-acquisition system, the software simplifies the design of process-monitoring and -control functions. You can use the PC first as a development system to configure a data-acquisition and -control algorithm, and then as a controller

CAD SOFTWARE

- Features 3-D polyline with five types of surfaces
- Works simultaneously with 2-D and 3-D elements

The AutoCAD software package, release 10, now runs on the Apple Macintosh and uses pull-down menus and icons to guide you. Fea-

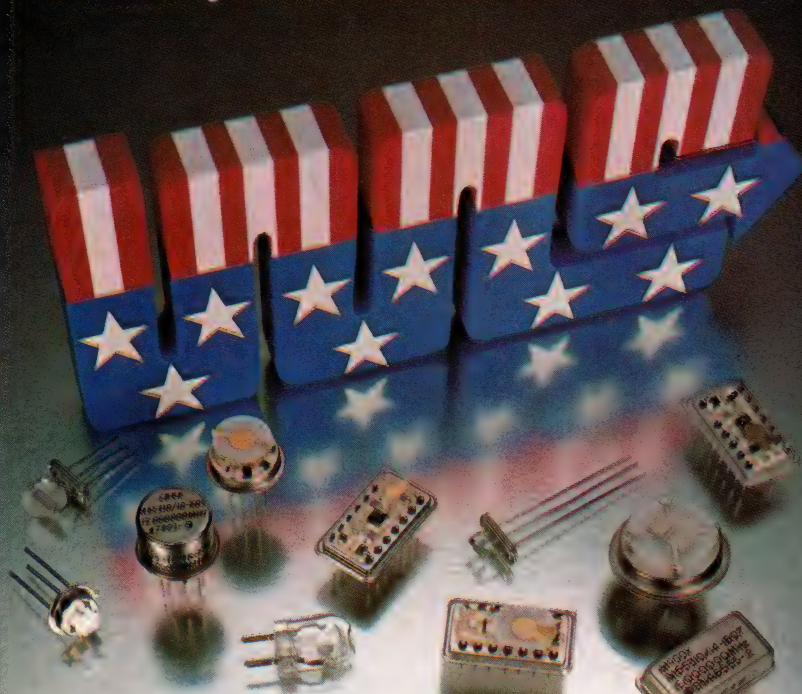
turing a 3-D polyline with five types of surfaces, the software performs simultaneously with 2-D and 3-D elements. A coordinate-system icon provides visual feedback. The software's interactive viewing lets you display multiple on-screen views. Its standard features include zoom, clip, pan, and project facilities. The software employs a proprietary ver-

sion of Lisp for programming. A graphics exchange facility lets you communicate with other CAD systems. \$3000.

AutoDesk Inc., 2320 Marinship Way, Sausalito, CA 94965. Phone (415) 332-2344. TLX 275946.

Circle No 439

Frequency Products for Aerospace, Military and Industrial Markets



McCoy IS ADVANCING AMERICAN TECHNOLOGY IN QUARTZ CRYSTALS, FILTERS AND OSCILLATORS

For over three decades McCoy Electronics Company has pioneered the custom frequency control industry, and has established leadership in its field.

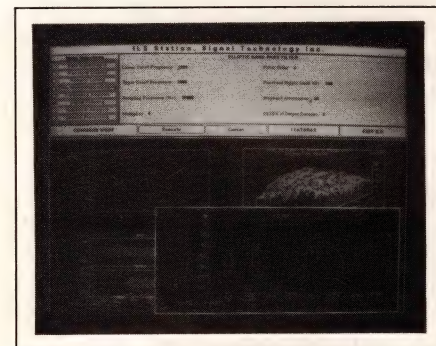
To assure the market place the finest performance available, McCoy manufactures all of its crystals, filters, and oscillators within the United States. The competitive challenge is being met technologically, economically, and with care to maintain the highest standards of quality.

For your next frequency control application consider McCoy. Write for free catalog.

McCoy
ELECTRONICS COMPANY

a subsidiary of OAK Industries Inc.

MT. HOLLY SPRINGS, PA. 17065 • 717-486-3411 - TWX: 510-650-3548



SIGNAL ANALYSIS

- Performs DSP analysis of time-series data
- Supports Apollo user-interface and graphics standards

The ILS (Interactive Laboratory System) signal-analysis package is now available for the Apollo 3000 and 4000 workstations. The software operates on digitized signal data stored in computer files. It lets you analyze the data using DSP techniques such as frequency analysis, digital filtering, numerical analysis, speech processing, and other forms of data manipulation. This version uses the Apollo Domain/Dialogue user-interface design and management system to provide a menu-driven operation for most DSP functions. You can easily modify and customize the menus. The multiple-window facility lets you view several different analysis steps simultaneously. The software conforms to the Apollo GMR (Graphics Metafile Resource) standard, which allows you to direct graphics output to any Apollo-supported output device. If you store graphics in a metafile, you can edit the file, share the file with other applications, or view the file on any Apollo workstation on the Domain local-area network.

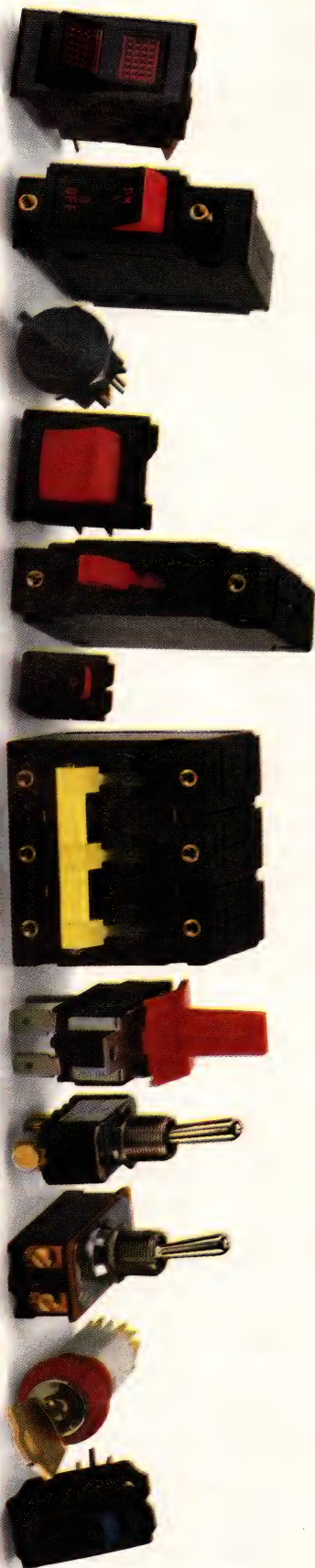
Turning on technology.

When technology needs to be turned on, Carlingswitch products can be trusted to do the job. For over six decades we've been setting the pace in new product design. Led by the innovative Curvette[®] rocker switches, Visi-Rocker[®] magnetic circuit breakers and interchangeable Lockette[®] keylock switches.

When technology demands attention, our sophisticated engineering team, computer integrated manufacturing system and state-of-the-art statistical process control assure quick and reliable solutions.

And when technology demands service, Carlingswitch professionally sup-

ports your needs with a worldwide stocking distribution network, backed by an experienced applications staff, and an international organization of engineering representatives and regional managers. Call toll free 1-800-243-8556. Carlingswitch, Inc. Plainville, Connecticut.



CARLINGSWITCH

INNOVATION BY DESIGN



RAD-HARD POWER

Meet your system survivability requirements and cut development time with IRT's fully tested Radiation Hardened DC-DC Converter.

Triple Output (+5V, ± 15 V). The HPS-3015 offers 30 Watts of total output power with 70% efficiency and meets the 18-50V dc input range of MIL-STD-704.

Compact. This 11-pin hybrid fits right on your circuit board. The flange-mount package is all metal, hermetically sealed, and only 3.6 x 3.0 x 0.6" in size.

Operate-through. The +5V output operates within $\pm 20\%$ of nominal voltage through a dose rate of 5×10^{10} rad(Si)/sec, insuring that continuous power will be delivered to your critical electronic circuits.

100% Tested. Operate-through performance is 100% tested in a dose rate environment and every unit is latchup free. Electrical and environmental screening references MIL-STD-883 test methods.

Guaranteed Performance. To meet your additional needs, the HPS-3015 DC-DC Converter's performance parameters are guaranteed in the ionizing dose rate, total dose and neutron fluence environments.

Call us today to get all the facts about off-the-shelf rad-hard power at (619) 450-4343.

IRT

CORPORATION

SURVIVABILITY PRODUCTS

3030 Callan Road
San Diego, CA 92121
(619) 450-4343 / Telex 69-5412

CIRCLE NO 214

\$5100 to \$12,500, depending on host's configuration.

Signal Technology Inc., 5951 Encina Rd, Goleta, CA 93117. Phone (805) 683-3771. TWX 910-334-3471.

Circle No 440

TIMING ANALYZER

- Performs worst-case analysis on ASIC and board designs
- Displays timing problems on schematic designs

The QuickPath analyzer performs worst-case analysis on ASIC and board designs, and displays timing problems on the schematic. You don't have to create vector stimuli in order to find setup and hold problems. The analyzer calculates path delays, then compares them to clock specifications. It supports multi-phase and multifrequency clocks. In addition, the analyzer locates fast and slow components on pc boards. Its algorithm works with gate-level, functional, behavioral-language, and hardware models. \$9900.

Mentor Graphics Corp., 8500 SW Creekside Pl, Beaverton, OR 97005. Phone (503) 626-1231.

Circle No 441



grams at shop-floor level. For on-site test purposes, you can download code to a PLC. The debug facilities let you monitor program execution at any level. The package includes pull-down menus, on-screen help, and documentation facilities. Approximately gld 5000.

Philips, Industrial & Electro-acoustic Systems Div., 5600 MD Eindhoven, The Netherlands. Phone (040) 788620. TLX 35000.

Circle No 442

Philips Electronic Instruments Inc., 85 McKee Dr, Mahwah, NJ 07430. Phone (201) 529-3800.

Circle No 443

CASE TOOL

- Lets you develop structured programs for PLCs
- Runs on an industry-standard PC

The PDS5 software package lets you develop programs for the company's PC20 and MC30 programmable logic controllers (PLCs) on an industry-standard PC. The package supports the graphic Sequential Function Chart (SFC) language. SFC employs embedded ladder-diagram and functional-block diagram languages. In addition, you can program using text coding. The SFC language obtains the program structure from a flow chart of the main control functions. This feature lets you develop structured pro-

CAE TOOL

- Checks pc-board designs for environmental reliability
- Analysis conforms to MIL-STD-217 standards

When combined with the vendor's Allegro pc-board design system, ThermoStats provides environment analysis. It allows you to analyze board-spacing, part-selection, air-flow velocity, noise, and thermal conditions. The tool indicates the MTBF of a pc board by checking the board's conduction, convection, and radiation effects. By examining driver/receiver pin pairs, the tool identifies components that are susceptible to noise. The tool takes 30 sec typ to process an analysis and display the results on a color-coded line graph, and provides a library with 1200 thermal models. The reli-

EDN's Technical Article Database Index is Now on Floppy Disk!

Now you can utilize EDN magazine's Technical Article Database Index right on your computer screen. When used with your IBM PC or compatible computer, this new floppy-based index gives you all the benefits of our printed index . . . and more:

- Fast computer searches and sorts
- AND and OR capabilities to precisely specify your search criteria
- Printout of search results

The index lists articles printed in EDN, EDN NEWS, Electronic Design, Electronics, Electronic Products, Computer Design, and ESD. Two installments are available—covering articles published from May to October, 1987, and from November 1987 to April 1988.

EDN'S index is compatible with most popular programs, including 1-2-3 from Lotus, MailMerge from MicroPro International, and dBASE from Ashton-Tate. It also works with Buttonware, Inc.'s PC-File+, a "shareware" database manager that you can order from us.*

Our Technical Article Database Index on your computer will mean added convenience for you. Order your copy today.

*EDN provides fully functional copies of PC-File+ for a nominal reproduction fee. Receipt of PC-File+ does not constitute ownership, which must be purchased from Buttonware for \$69.95 if you continue to use the program, but merely the right to evaluate the program's capabilities. EDN assumes no responsibility for the programs operation.

PC-File+ runs on IBM PCs and compatible computers and requires 384k bytes of memory, two double-sided floppy disk drives or one double-sided floppy drive and a hard disk, an 80-column display, and MS-DOS or PC-DOS version 2.0 or later.



ORDER FORM

EDN's Technical Article Database Index on IBM PC DSDD floppy disc

Installment 1 May 1987–October 1987)	_____ copies at \$19.95 = _____ (\$21.95 for non-US)
Installment 2 November 1987–April 1988)	_____ copies at \$19.95 = _____ (\$21.95 for non-US)
PC-File+ database software (3 disks) (available only in US, Canada, and England)	_____ copies at \$14.95 = _____ (\$16.95 for non-US)
	TOTAL _____

Check or money order made out to EDN Reprints must accompany each check. No COD. Massachusetts residents add 5% sales tax. Foreign checks must be drawn on a US Bank, issued in US currency.

Send to:

Technical Article Database Index
EDN Magazine
Publishers Building
15 Washington Street
Newton, MA 02158-1630

Please Print clearly.
This is your mailing label.

NAME _____

TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____ ZIP _____

ability analysis conforms to the requirements of MIL-STD-217. The ThermoStats package runs on Sun 3, 4, and Digital 3000, GPX II workstations. \$15,000.

Valid Logic Systems, 2820 Orchard Parkway, San Jose, CA 95134. Phone (408) 432-9400. TLX 3719004.

Circle No 449



STRUCTURED BASIC

- Includes statements for data acquisition
- Provides structured-programming format

The MBC-Basic high-level programming language is compatible with GW Basic and BasicA. However, the language has extensions that let you tailor programs to the needs of a specific data-acquisition and -control application. New control-flow

keywords let you create structured procedures and functions similar to those of C or Pascal. You can declare variables as either global or local to a procedure. You can create libraries of pretested, error-free code for repeated use. The language also lets you create your own keywords, and the package comes with a number of

these special keywords that are created specifically for the vendor's Metra-bus family of process-control and data-acquisition devices. Unlike other Basic implementations, which are restricted to 64k bytes of memory, MBC-Basic allows you to access the full 640k bytes available to DOS. \$195.

MetraByte Corp, 440 Myles Standish Blvd, Taunton, MA 02780. Phone (508) 880-3000. TLX 503989.

Circle No 444

NUMBER GENERATOR

- Generates double-precision random numbers
- Lets you select various probability distributions

The RanGen software package performs high-speed generation of double-precision random-number sequences with uniform, Gaussian

If you want to see the real screens . . . contact one of our distributors.

A.I.M. ELECTRONICS
376 Churchill, Suite 108
Ottawa, Ontario
Canada K1Z 5C3

AIR-PARTS INTERNATIONAL B.V.
Kalkovenweg 12
2401 LK Alphen aan den Rijn
The Netherlands

AIR-PARTS ELECTRONICS
Huart Hamoiriaan 1
1030 Brussels
Belgium

ARS MICROSYSTEMS LTD.
Doman Road
Camberley, Surrey
GU153DF United Kingdom

GTS ENGINEERING
5 Porters Avenue
Eden Terrace
Auckland, New Zealand

JEROME & FRANCIS CO. LTD.
1869 Welch
No. Vancouver, B.C.
Canada V7P 1B7

KENELEC (AUST) PTY. LTD.
48 Henderson Road
Clayton, Victoria
Australia 3168

MACROTRON AG
Stahlgruberring 28
D-8000 München 82
Germany

MEDEA SRL
Via L. da Vinci, 143
Trezzaano sul Naviglio (Milano)
Italy

SAINTEL
L'Oree d'Ecully
Chemin de la Forestiere
69130 Ecully, France

SILICON INSTRUMENTATION
705 Sims Drive #05-04
Shun Li Industrial Complex
Singapore 1438

SOLUSTAN, INC.
320 Odhav Road
Ahmedabad 382410
India

TOPWARD ELEC. INSTRUMENTS CO.
No. 26, Gong 4th Road
Linkou 2nd Industrial Park
Taipei Hsien, Taiwan

TRACO ELECTRONIC AG
Jenatschstrasse 1
CH-8002 Zürich
Switzerland

UNIVERSAL INSTRUMENTS CO.
Room 1408, Guardian House
Oi Kwan Road
Wanchai, Hong Kong

YA-MAN LIMITED
4-13-4 Hachobori
Chuo-ku, Tokyo 104
Japan

ECHO — a reality, not a promise.

ARIUM
CORPORATION

Now benchpress 400 MHz. Easy.

Arium introduces The Tool for your bench. The 400 MHz logic analyzer at a price you can handle as easily as the ML4400 handles multiple pods simultaneously . . . starting at \$4995.

Arium does it again.

We just redefined high-end logic analyzers in terms of low-end cost. With the 8/16/32-bit ML4400, you can combine up to four independent-clock cards (user-selectable) to get 16 channels at 400 MHz, 64 channels at 100 MHz (synchronous), or 160 at 50 MHz (synchronous). That means you can now handle full-speed 68030s or 80386s, as well as 68020s and 8086s. And, uniquely, up to four different microprocessors, simultaneously. That's speed our competition can't catch up with. Now for ease of use.

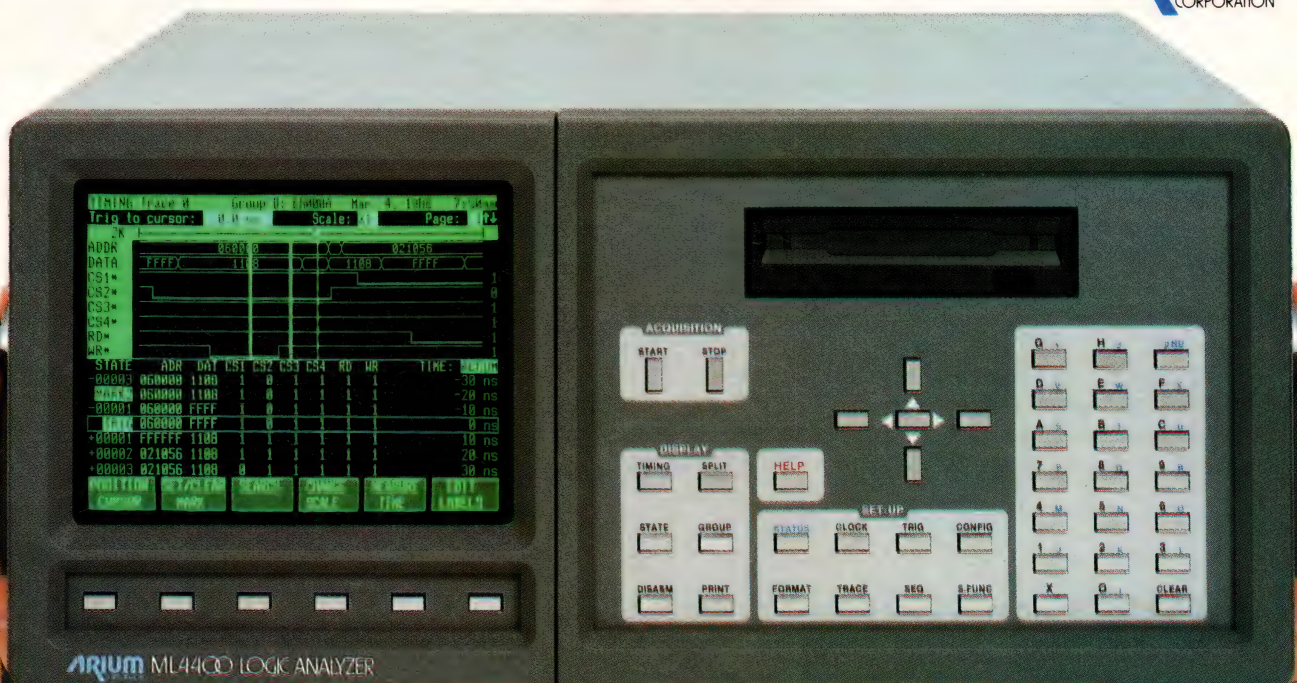
Easy. Redefined. What does ease of use mean to you? If it means: Single key menu access to all

screens. Complex triggering (Boolean, multilevel, repeat functions) with cross-triggering between state and timing, and between pods. Cross-time stamping. Transitional timing. All software resident . . . Then, you'll find them all, and more, in the ML4400.

Why Arium? How can Arium be the first to put this much low-cost power on your bench? Because we've always been first, ever since we redefined performance/price logic analyzers with our ML4100. When will the competition catch up with the performance/price of our new ML4400? Don't hold your breath.

For more data on the new ML4400, as well as on our family of Arium 8/16/32-bit logic analyzers at prices as low as \$2495, contact **ARIUM CORPORATION**, 1931 Wright Circle, Anaheim, CA 92806-6052. Telephone 800/TO-ARIUM (800/862-7486), (714/978-9531 in CA).

ARIUM
CORPORATION



Arium does it again!

CIRCLE NO 219

(normal), lognormal, weibull, exponential, and other probability distributions. The only limit on the size of the sequences is the amount of disk space available to store them. The software lets you select the specific quantity of random numbers that you require. You can scale the numbers to a desired range and sum them. You can specify key parameters

such as the mean and the variance of the distribution needed; if you don't specify these parameters, the program uses the defaults of zero-mean and unit variance. \$29.95.

Signal Analysis Research, 8301 Thomas Ave N, Minneapolis, MN 55444. Phone (612) 560-8166.

Circle No 445



Why Do So Many Engineers Specify Keeper II® Lithium Batteries?



Because Board Space Is Too Valuable To Waste

At Eagle-Picher, we don't think you should have to compromise valuable circuit board space simply because some battery manufacturer elected to make round batteries.

Electronic circuit board "real estate" is becoming increasingly valuable. Consequently, engineers are faced with more complex decisions regarding their back-up power source. Keeper II's unique prismatic configuration provides effective utilization of board space with maximum energy density characteristics.

Packaged the way circuit board components were meant to be, the Keeper II has been proven highly dependable in stand-by power applications where years of reliable memory back-up is required. Eagle-Picher manufactures 100% of the Keeper products in the USA.

So, no matter what your power requirements are, count on Eagle-Picher. Because Board Space Is Too Valuable To Waste.

EAGLE PICHER

ELECTRONICS DIVISION

Box 130 • Bethel Road • Seneca, MO 64865

Phone: 417-776-2256 • TWX: 62864271 • FAX: 417-776-2257

CIRCLE NO 220

DEBUG TOOL

- Provides hardware and software debug facilities
- Runs in real time without speed problems

The Adapt29K, a RISC (reduced instruction set computer) μ P development tool, provides both hardware and software debug facilities. According to the vendor, it runs in real time without encountering speed problems. The tool supports a 29k-byte max development project and provides ROM-resident software with an assembler. The software allows you to set eight breakpoints; to read from and write to I/O lines; to trace code execution; and to download files. Running on ASCII terminals and host computers, the tool catches bus signals at 40 MHz max. It plugs into the CPU socket and runs directly on the target processor. \$8500.

Step Engineering, Box 3166, Sunnyvale, CA 94088. Phone (800) 538-1750; in CA, (408) 733-7837. TWX 910-339-9506.

Circle No.446

CAE SYSTEM

- Lets you design and simulate in an interactive mode
- Allows you to work on more than 30,000 gates

The Workview 3000 provides an ASIC design system for 386-based computers that lets you design and simulate in an interactive mode. The schematic capture lets you use the mouse, the keyboard, or macros for your instructions. The system provides 60 primitives that operate at

Plessey Microsystems

Your best defense for Mil Spec and severe environment applications

NOW RADSTONE
TECHNOLOGY



- Military VME
- Military Multibus
- Bubble Systems
- Custom Military & Severe Environment Products

For applications from military to ruggedized, your best defense is the ultimate source for microprocessor and memory systems—Plessey Microsystems. No one else can deliver such a broad range of standard and custom products for severe environment and high-rel applications, military or ruggedized.

PMM 86 Multibus Microcomputer Systems

A full range of Intel-compatible processors, memory, controllers, and interfaces, including CMOS versions. Extensive, reconfigurable BITE. Complete ATR box systems and software support. Mil Spec and ruggedized versions.

PMV 68 VMEbus Microcomputer Systems

Totally VMEbus-compatible 68020-based 32 bit architecture. Processors, memory and interfaces... all with full Mil Spec compliance. Plus

a complete range of industrial grade hardware, software and development systems.

Bubble Memory Modules and Systems

The world's broadest and most reliable range. Mass storage systems to 48 Mbytes. Complete, modular and cartridge systems for embedded, stand-alone or disk replacement applications.



Custom System Capabilities

Unparalleled expertise in custom product development for all military and severe environment applications. Automated design and manufacturing capabilities. For your most demanding and most specialized Mil Spec and hostile environment needs.

From the Ultimate Source

For details on the most comprehensive range of high reliability microprocessors and memory systems, just call or write Plessey Microsystems. If our standard products or systems don't meet your needs precisely, we'll custom design one that will.

Plessey Microsystems

USA

One Blue Hill Plaza
Pearl River, NY 10965
Tel: (914) 735-4661
TWX: (710) 541-1512

9 Parker
Irvine, CA 92718
Tel: (714) 472-2586

Suite 600
2000 E. Lamar Blvd.
Arlington, TX 76006
Tel: (817) 261-9988

FRANCE

BP 74.7-9 rue Denis Papin
78914 Trappes Cedex
Tel: (1) 30.51.49.52
Telex: 696441

GERMANY

D-6090 Rüsselsheim
Bahnhofstraße 38
Tel: (061 42) 6 80 04
Telex: 1761 4293

UNITED KINGDOM

Water Lane, Towcester
Northants NN127JN
Tel: (0327) 50312
Telex: 31628



PLESSEY

gate, switch, and functional levels. Timing simulation facilities let you check setup, hold, skew, pulse-width, and recovery violations. In addition, the system allows you to work with more than 30,000 gates. The vendor offers design kits with design-rules checkers and bidirec-

tional interfaces for analog and pc-board designs. From \$10,000.

Viewlogic Systems Inc, 275 Post Boston Rd W, Marlboro, MA 01752. Phone (617) 480-0881. TLX 174242.

Circle No 447

PLD

- Features ladder-logic software with an interactive mode
- Has a battery-backed RAM with eight inputs

The D100 PLD provides a controller with interface modules and ladder-logic software. The software runs on the IBM PC, PC/XT, PC/AT, and compatibles. The controller comes with a battery-backed RAM with eight inputs. The device's features include six 24 to 240V ac/dc outputs; a 2-kHz max counter with 32 presets; and two 8-bit A/D channels with 12 presets/channel. The ladder-logic software lets you make in-



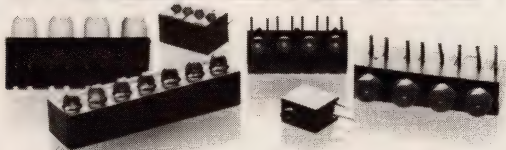
teractive programming changes. A graphics-oriented interface provides visual feedback of your code. Controller and software, \$325 each; RS-232C converter and cable, \$55; interface card, \$180.

Acculex Co, 440 Myles Standish Blvd, Taunton, MA 02780. Phone (617) 880-3660. TLX 503989.

Circle No 448



Whose arrays are PREFERRED



for quality, value & availability?

Data Display Products has the answer you'll prefer when it comes to high quality, low cost arrays.

And now introducing our new variable array. Designed for high density packing, it's a direct replacement for the Dialight 551 PCB series. Precisely aligned and easy to handle, additional features include a built-in recess for improved solderability. We have a shining selection in sizes of 1 to 8 modules with 2.4, 5 and 12 volt operation. Availability is guaranteed even in mixed colors.

Make the brilliant choice. Call Data Display, TOLL FREE (800) 421-6815. Within California, call (213) 640-0442. Free Catalog.



P.O. Box 91072, Los Angeles, CA 90009
(213) 640-0442, TELEX 664-690, FAX 213-640-7639

INTERNATIONAL REPS: Argentina YEL SRL, PH: 541 462211, TLX: 390 18605 - Australia Ampec, PH: 6893522, TLX: 790 127136 AMPEC, FAX: 612 6335448 - Belgium/Holland Klaasing Eic, PH: 01620 81600, TLX: 844 54598 KLBNDL, FAX: 0162056500 - Denmark Radio Parts, PH: 01 333311, TLX: 855 19613 RPARTDK - France A. Jahnichen, PH: 387 59 09, TLX: 842290714, FAX: 013111-4387-3319 - Israel R.C.M. Computers, PH: 03 476225, TLX: 922 341390 IL, FAX: 011-972-491942 - Italy Microdata, PH: 0187 968182, TLX: 8432 22070 - South Africa Liberty Elec., PH: 52 7637/8/9, TLX: 960 867325 SA - Spain Betatron, PH: 6942511, TLX: 831 23911 PCOE - United Kingdom Marl Int'l, PH: 0228 52430, TLX: 851 65100 MARLG, FAX: 0229-55155 - West Germany/Austria Kuhn GmbH, PH: 06235 5662, TLX: 841 464766 KUHNND, FAX: 0623581955

Litton's LCD's Help You In Two Ways— Quality and Delivery.



All of Litton Data Images Liquid Crystal Displays are built and designed to high REL specifications. To support this commitment, we also ensure that LCD's are delivered on time and to your specific requirements.

Our LCD's are custom designed to meet your individual demands and are available in twisted nematic or guest host/dichroic or dye enhanced TN. Litton can supply just the LCD glass or a complete module including the electronics, and can be back-lighted to meet NVG specs. In addition, they conform to MIL -55c to +85c specs.

Litton Data Images provides the high-quality Liquid Crystal Display you require, with the delivery you expect.

Litton

Data Images

If you have any questions or immediate needs, please call our Display Engineering Group at (613) 744-3773.

EDN PRODUCT MART

This advertising is for new and current products.

Please circle Reader Service number
for additional information from manufacturers.

Electronic Engineering File System Software Package. **** JUST \$27.00 ****



Organize your product catalogs and technical information with the **Electronic Engineering File System**. Features include unlimited library expandability, custom filing labels, EEM filing code compatibility, and a 30 day money back guarantee.

Kit Contents:

- Electronic Engineering File System software
- Software Manual
- 1000 Computer Printer Labels

Hardware Requirements:

- IBM PC/XT/AT/PS2 or 100% compatible
- Epson dot matrix printer or 100% compatible

REL & Associates

P.O. Box 729, Springfield, VA 22150
(800) 634-5463 Ext. 112 In Iowa (800) 542-7981 Ext. 112

CIRCLE NO 325



"The Best 8051 Emulator"



NEW
Pull Down
Menus with
Context
Sensitive
Help

8051

PC based emulators for the 8051 family

(8051, 8751, 8052, 8752, 8031, 8032, 8344, 80C452, 80C152, 80535, 80C451)

- PC plug in boards
- Command driven User Interface with static windows
- 16 MHz real time emulation
- 128K emulation memory
- 48 bit wide, 18K deep trace buffer with loop counter
- Program performance analyzer
- Powerful Macros with IF-ELSE, REPEAT, WHILE structures
- Single step in PL/M-51 and C-51
- Symbolic debugging with in-line assembler and disassembler
- No external boxes
- Pull down menus w/context sensitive help
- Trace can be viewed during emulation!

PRICES: 32K Emulator for 8031 \$1790, 4K Trace \$1495

CALL OR WRITE FOR FREE DEMO DISK!

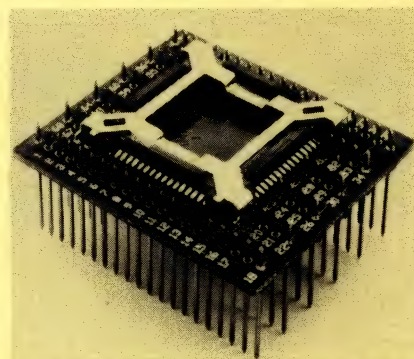
Ask about our demo VIDEO!

NOHAU

CORPORATION

51 E. Campbell Ave. #107E, Campbell, CA 95008 (408) 866-1820

CIRCLE NO 326



LEADLESS CHIP TO WIRE WRAP ADAPTERS

Save prototyping time, these LCC, PCC and PGA socket adapters provide the designer with a labeled test point for each pin and are available for 28, 44, 52, 68 and 84 pin chips. WW pin rows are on .3" centers. Unit pricing for the 68 pin version is \$49.00 delivered from stock.

Antona Corporation

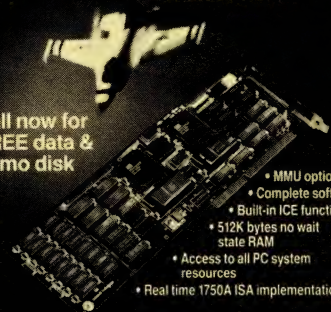
1643 1/2 Westwood Blvd., L.A., CA 90024
(213) 473-8995

CIRCLE NO 327

MIL-STD-1750A

CO-PROCESSOR BOARD
For PC/XT/AT compatibles

Call now for
FREE data &
demo disk



- MMU option
- Complete software
- Built-in ICE functions
- 512K bytes no wait state RAM
- Access to all PC system resources
- Real time 1750A ISA implementation



Another industry first from
Sabtech Industries

3910-B Prospect Ave, Yorba Linda, CA 92686
(714) 524-3299 - Fax (714) 524-3290

CIRCLE NO 328

PROTECT YOUR INVESTMENT

Power up with ... **Z-LINE**



AC Power Distribution and Control System Model TPC 115-10A MTD™ space saver design for clean power up with Multiple Time Delay™ prevents high current inrush by sequencing your computers power up. Filters AC line voltage and protects your system from voltage spikes and surges. Priced from \$436 to \$305.

To order call:

(714) 540-4229

FAX 714-641-9062

or write

Pulizzi Engineering Inc.
3260 S. Susan St.
Santa Ana, CA 92704-6865

CIRCLE NO 329



GANG/SET (E)EPROM MULTIPROGRAMMERS™

Model 135-E: \$995⁰⁰

- BYTEK's 135 is a SET Programmer, GANG Duplicator, & UNIVERSAL Device Programmer.
- Programs virtually all 24, 28, & 32-pin (E)EPROMs.
- RAM expandable to 2MegaByte.
- Optional support for 40-pin EPROMs, Bipolar PROMs, 40-pin Micros, & (E)PLD/GAL/FPLA Devices.
- **18-Month FREE WARRANTY and also 12-Month FREE DEVICE UPDATES.**

1-800-523-1565

In Florida: 1-407-994-3520

BYTEK

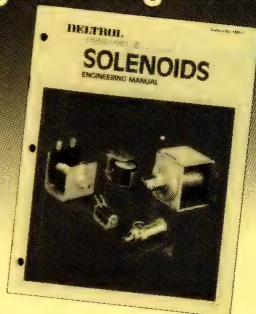
BYTEK Corporation
508 N.W. 77th St., Boca Raton, FL 33487
FAX: (407) 994-3615 Telex: 4998369 BYTEK

* [U.S. Prices only]

CIRCLE NO 330

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

SOLENOID Engineering Manual



Send for the latest 68-page Solenoid Engineering Manual from Deltrol • Packed with useful information including performance data, stroke/force curves, selection factors • Industry's broadest range of miniatures, C frames, D frames, power surge, and tubular solenoids.

DEL TROL
controls /

2745 S. 19th St.
Milwaukee, WI 53215
Phone 414/671-6800
Telex 2-6871

4305-1 DIVISION OF DELTROL CORP.

CIRCLE NO 331

AMX 68000

KADAK's engineers bring years of practical real-time experience to over 600 installations world-wide.

This real time MULTITASKING KERNEL simplifies real life product development

- No royalties
- Full source code included
- C interface
- Preemptive scheduler
- Interrupt messages
- Terminal Handler
- Dynamic memory allocation
- Event Manager
- Semaphore Manager
- Resource Manager
- Buffer Manager

AMX 68000 operates on any 68000/10/20 system

Manual only \$75 US
AMX 68000 \$1600 US
* Options — ask for price list.
(Shipping/handling extra)

Also available for 8080, 280, 8086/186/286

KADAK Products Ltd.

206 - 1847 W. Broadway
Vancouver, B.C. Canada V6J 1Y5
Telex: 04-55670
Fax: (604) 734-8114
Telephone: (604) 734-2796

CIRCLE NO 332



IF YOU DO IC WORK, YOU NEED Quick-Catch™! Simply the best PLCC/LCC wire-wrap socket for all your processor needs - prototype or production. 44, 68, and 84 pin configurations for over 50 PLCC/LCC packages. Glass reinforced thermoplastic construction assures rugged quality, and .025" probe holes makes your testing easy. Three-position high pins are spaced at .100", allowing you room for fast wire-wrap work. \$29.95 for the 68 pin configuration + \$1.50 S+H. MC and VISA accepted. Quantity price breaks available. Distributor inquiries welcome. Eclipse Technologies, Inc, 1835 E. Charleston, Suite #22, Las Vegas, NV 89101, 702-388-1330.

CIRCLE NO 334



MOUSE-TRAK The Stationary Alternative For Precision and Comfort!

This new space saving input device emulates both Microsoft and Mouse Systems RS-232 mice. With MOUSE-TRAK you can watch your screen and not your mouse running off your desk.

With a single connection to your computer, no power supply or mouse pad is necessary.

MOUSE-TRAK's ergonomic design with soft wrist pad puts complete control of cursor and input at your fingertips.

Special features include speed control, allowing the user to toggle the resolution with a 4:1 ratio. User definable input keys offers added versatility and comfort.

Pricing - \$139.00 - \$179.00

For further information:

ITAC SYSTEMS, INC.

3121 Benton Drive, Garland, Texas 75042 U.S.A.

1-800-533-4822 Fax 214-494-4159

CIRCLE NO 335

Custom Engineered Toroidal Transformers

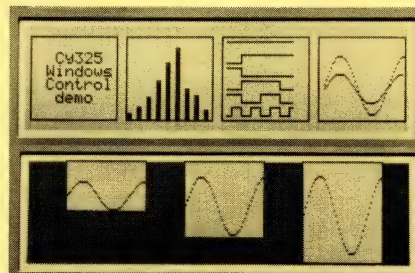
Spang Supplies Solutions...Fast!

At Spang we're more than just a winding house, and our extensive experience proves it. Our engineers will detail the best overall design to meet your exact requirements. For fast solutions, call the toroidal transformer experts at Spang, or write for our free brochure.

Spang Power Control

P.O. Box 457 - Sandy Lake, PA 16145
(412) 376-7515 - FAX 412-376-2249

CIRCLE NO 337



LCD WINDOWS CONTROLLER

The CY325 supports LCDs up to 128x240 pixels (16x40 char) with easy-to-use high-level commands and Parallel or Serial interface to host computer. The 256 built-in windows (or make your own) support window-relative text, graphics, plotting, bargraphs, waveforms, scroll/wrap/clip, etc. Read from an A/D and Write into Window! Separate text and graphic planes can be written or erased in any window. Eight pins support a variety of functions (soft-keys, waveforms) or can be used for GP I/O. Icons or special fonts can be user defined. Giant character mode, etc. Save months of design time with the CY325. \$75 CMOS \$20/1000s.



Cybernetic Micro Systems Inc.

P.O. Box 3000 • San Gregorio, CA 94074 • USA
Phone: (415) 726-3000 • Telex: 910-350-5842

CIRCLE NO 338



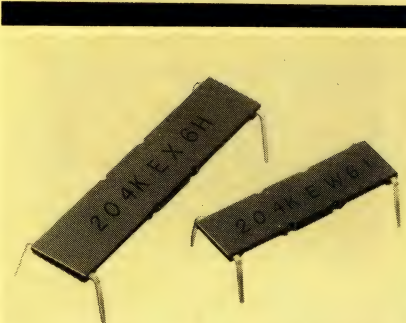
RS-232, RS-422, & TTL SERIAL DATA ANALYZER

Real time display on PC or dumb terminal • 3 to 64,000 baud • Switch matrix with LEDs • 16 byte pre/cntr/post triggers • ASCII/Hex display • 24k buffer • Non Volatile setup • Printer output • Help menus • SCC UART • 2x38,400 baud at max character rate • Post capture search • Parity/Framing error display • Customizations • Visa/MC

WARDEN TRONICS

33 Standen Dr., Hamilton, Ohio 45015 (513) 874-1211
10 day free trial • Model AK-47 \$795

CIRCLE NO 333



MICRO/Q II

FOR A DECOUPLING CAPACITOR THAT SAVES SPACE, DEFEATS NOISE, IS SUITABLE FOR MILITARY APPLICATIONS AND BEATS HUMIDITY, HEAT AND COLD:

ROGERS MICRO/Q® 2000

Rogers Corp., 2400 S. Roosevelt,
Tempe, AZ 85282. 602/967-0624

CIRCLE NO 336

72 DIGITAL I/O FOR PS/2



MODELS 50, 60, 80

- Parallel Expansion
 - 72 I/O Lines
 - Address Selectable
- 1-800-553-1170**

GUA TECH
INCORPORATED

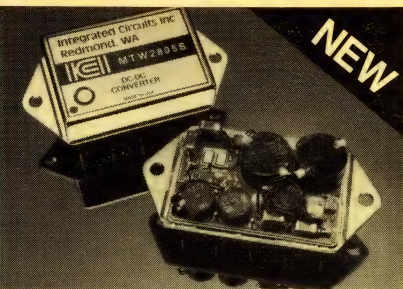
478 E. Exchange St., Akron, OH 44304

TEL: (216) 434-3154 FAX: (216) 434-1409

TLX: 5101012726

CIRCLE NO 339

To advertise in Product Mart, call Joanne Dorian, 212/463-6415



NEW

DUAL OUTPUT 30 WATT MINIATURE DC-DC POWER CONVERTER

These HI-REL power converters are now available in dual output configurations:

- ± 12 VDC @ ± 1.25 A, and ± 15 VDC @ ± 1 A.
- Up to 86% efficiency
- 500 VDC isolation
- Input range 18 to 40 VDC
- Additional environmental screening available
- 22.8 Watts/in³
- Short circuit protection
- Metal packages ideal for military, aerospace, and other HI-REL applications

The dual-output MTW devices are priced at \$487.00 each (100 quantity). For more information, contact:

INTEGRATED CIRCUITS INCORPORATED
10301 Willows Road, Redmond, WA 98052
800-822-8782

CIRCLE NO 340



NEW LOW PROFILE TRACKBALL

The Model 625 low profile trackball uses a large 2.5 inch diameter ball while keeping the below panel space to 1.5 inches. It provides for quadrature square wave output for each axis. Cursor positioning tasks are quickly accomplished because nearly 40% of the ball is exposed making both slewing and precise positioning easier.

Measurement Systems, Inc.

121 Water Street, Norwalk, CT 06854
(203) 838-5561

CIRCLE NO 341



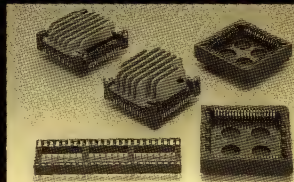
SAVE SPACE WITH MINI/BUS® BARS

- Improve power distribution
 - Reduce required board layers
 - Eliminate up to half the decoupling capacitors
 - Fit between or beneath IC's
- Send for Rogers Mini/BUS® Bars Application Bulletin.**

Rogers Corp., 2400 S. Roosevelt St.
Tempe, AZ 85282 602/967-0624

CIRCLE NO 342

WINPOINT A FULL RANGE OF CONNECTORS & SOCKET



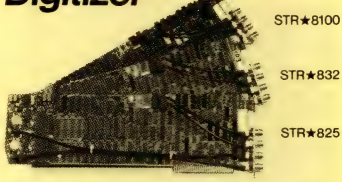
IC SOCKETS-8, 14, 16, 18, 20, 22, 24, 28, 40, 42, 48 contact
LCC SOCKET-68 contact
PLCC SOCKET-28, 32, 44, 52, 68, 84 contact series



Winpoint Electronic Corp.
P.O. Box 89-80, Taipei, Taiwan, R.O.C. Office: No. 47, Chi-Wei St., San Chung City, Taipei, Taiwan, R.O.C.
Tel: (02) 986-0208, 984-0209
Telex: 34227 WINPOINT Fax: 886-2-9838555

CIRCLE NO 343

100 MHz Waveform Digitizer



STR★8100

STR★832

STR★825

The fastest A/D boards for your data acquisition needs.

- transient rates of 25, 32, and 100 MHz at 8 bits
- time equivalent sampling rates up to 800 MHz
- bus interface allows 1.5 MHz throughput rates
- many trigger modes; 64K memory per channel
- XT, AT & 386 compatible; prices from \$1750
- free drivers and digital oscilloscope software
- perfect for radar, ultrasound, ATE, robotics...

SONOTEK

8700 Morrisette Drive, Springfield, Virginia 22152
703-440-0222 ■ Telex 910-250-5257 ■ Fax 703-440-9512

CIRCLE NO 344

DOT MATRIX LCD



MODULES

- 1x8 to 4x80 sizes • .15" to .5" character heights • On-board controller
- 8-bit parallel input • Reflective, transmissive; positive or negative images
- -20°C to +70°C operating temperature
- EL and LED backlighting available
- Supertwist models in most sizes and formats

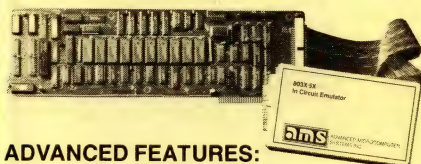
SHELLY
associates

(714) 669-9850

14281 Chambers Rd. • Tustin, CA 92680
TLX: 85-2263 • FAX: 714-669-1081

CIRCLE NO 345

803X/805X In Circuit Emulator For \$495



ADVANCED FEATURES:

- 64K of emulation memory
- 64K break points
- 1.5K trace buffer with 7 user test probes
- POD for emulating 8031, 8051*, 8032, 8052*, and 8053* microcontrollers
- 12 Mhz local microcontroller clock source
- Emulator to PC interface and support software on a 5 1/4" Floppy disk
- User manual
- 1 year limited warranty

ADVANCED MICROCOMPUTER SYSTEMS, INC.
1321 N.W. 65th Place • Ft. Lauderdale, Florida 33309
Phone (305) 975-9515



**CALL TOLL FREE
1-800-9PC-FREE**

CIRCLE NO 346



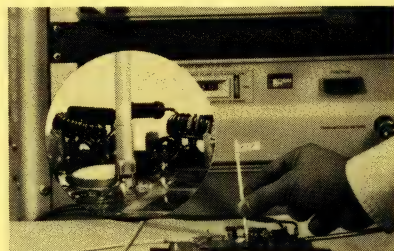
WIDEBAND INSTRUMENTATION RECORDER/REPRODUCERS CATALOG

Airborne, shipboard and laboratory magnetic tape and disc recording/storage/reproducing systems for military and industrial applications are described in a new comprehensive catalog. For a free copy contact:

Precision Echo, Inc.
3105 Patrick Henry Drive, Santa Clara, CA 95054
408/988-0516

"Where unique data recording/storage solutions are expected."

CIRCLE NO 347



NEW FROM ATC: TUNING STICKS \$49.95

Select the capacity value your circuit needs with ease. Now during bench test or design, value selection can be achieved without soldering capacitors in.

A Tuning Stick consists of an ATC 100 Series Superchip* permanently attached to a non-conductive holder. The Stick material is selected so that its effect on the capacitance value and Q is minimal.

Tuning Stick Kits contain 20 values ranging from 0.1pF to 1000pF. Kits are available off the shelf. Request ATC TS1001. 48 Hour QUIK-PICK™ Shipment.



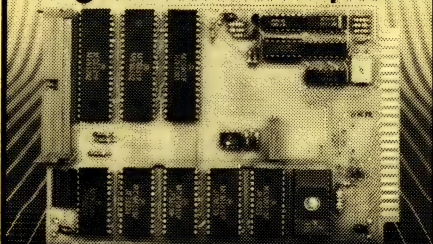
american technical ceramics corp.
one norden lane, huntington station, n.y. 11746-2102
516-271-9600 • telexes 221201 • 825707 • fax 516-271-9615

CIRCLE NO 348

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

\$91.00*

Single Board Computer



*500 piece price, model MCL45 (shown)

6800 MPU, serial I/O, parallel I/O, RAM, EPROM, 44-pin 4.5" x 6.5" PCB
EXPANSION MODULES: RAM, EPROM, CMOS RAM/battery, analog I/O, serial I/O, parallel I/O, counter/timer, IEEE-488, EPROM programmer, floppy disks, cassette, breadboard, keyboard/display.

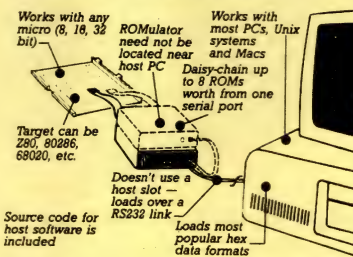


Wintek Corp.
1801 South Street
Lafayette, IN 47904
317-742-8428
(800) 742-8809

CIRCLE NO 349

Still Blasting ROMs?

Develop and test ROM code in minutes without leaving your keyboard — with The ROMulator™.



Ask us about faster (than 150ns) ROMulators and custom cables for most non-27xxx ROM sizes.

FOR MORE INFORMATION, PLEASE CALL OR WRITE



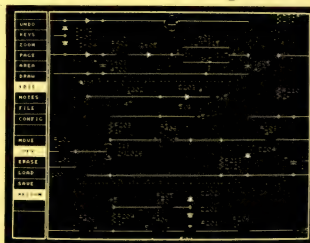
VISA and MasterCard Accepted
Dealer Inquiries Welcome

Grammar Engine, Inc.
3314 Morse Road
Columbus, Ohio 43229
614/471-1113

In California, call:
415/595-2252

CIRCLE NO 350

SCHEMA II Schematic Capture



FREE Demo Disk: 1-800-553-9119

SCHEMA's success is the talk of the CAE industry and thousands of satisfied SCHEMA owners know why. Incredible speed, ease of use, and power have made SCHEMA a best-selling schematic capture program for engineering professionals the world over.



Now, SCHEMA II is available. SCHEMA II sells for \$495 and supports most common IBM PC/XT/AT configurations. Please call today for a free SCHEMA II demo disk.

OMATION

In Texas Call (214) 231-3167

CIRCLE NO 753

FREE
CATALOG
AND APPLICATIONS GUIDE

**AFFORDABLE
ENGINEERING
SOFTWARE**

PC/MSDOS — Macintosh — CP/M

ACNAP — \$125.00 AC Network Analysis, Component Libraries, Macros, AUTO Execute	LCFIL — \$95.00 LC Filter Design/Analysis/Synthesis
DCNAP — \$95.00 DC Network Analysis, Component Libraries, Macros, AUTO Execute	LSP — \$95.00 Logic Circuit Design/Simulation
SPP — \$125.00 Signal Processing Program Macros, AUTO Execute, Windowing	RIGHTWRITER — \$95.00 Report Proofreader Program, Applies 3000 Rules of English
PLOTPRO — \$72.95 Scientific Graph Printing	PDP — \$95.00 Scientific Plotting Program for Pen Plotters
PCPLOT3 — \$95.00 High Resolution Engineering Graphics Package	TEKCALC — \$95.00 Programmable Scientific Calculator/Statistics/Curve-fitting
LOCIPRO — \$95.00 Root Locus Stability Analysis Multiple, Nested Loops	COMCALC — \$72.95 Communications Budget Calculator and Spreadsheet Program
ACTFIL — \$95.00 Active Filter Design, Analysis, Synthesis	XFER — \$95.00 Transfer Function Analysis and Circuit Synthesis
MICRO-3 — \$125.00 Design & Analyze Microstrip Circuits, Filters, Hybrids, Couplers, Transformers	SPANNER — \$95.00 Integrated Word Processor, HP11C Calculator, and Scientific Graphics

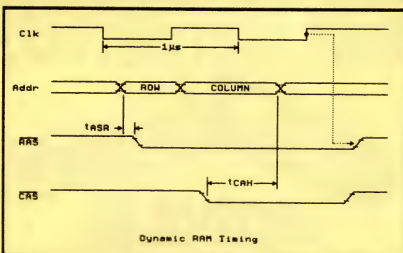


Engineering
Professional Software



2023 Chicago Ave, Suite B-13, Riverside, CA 92507 U.S.A., TELEX-308966

CIRCLE NO 751



TIMING DIAGRAM SOFTWARE

Design Aid:

Quickly draw and edit waveforms.

Documentation Tool:

Easily label waveform drawings.

IBM PC with mouse required.

To order Timing Diagram, send check or money order for \$149 to:

CEDRUS

10980 S. W. 81st, Tigard, OR 97223 (503) 620-2510

CIRCLE NO 752



EPROM PROGRAMMER WITH AUTO-PROGRAMMING

The Model 93 includes automatic selection and program/verify with silicon identifiers. RS-232C to 19.2 KB; Intel, Motorola, Tektronix and extended formats with offset, even/odd, byte split, checksum, Quick Pulse and standard programming. Full COM1:-COM6: support on IBM PC/XT/AT. CP/M driver. Supports 27XXX, 25XX, 87CXXX, 87C257, 68C257 MCM68764 EPROMs; 8741 — 87C51-8752 MPU; 28XXX EEPROMs. \$350

Optimal Technology

Earlsville, VA 22936 804-973-5482

CIRCLE NO 754



MIL-STD-1553 Interface Board For IBM-PC/XT/AT or Compatibles

Dual redundant bus controller, remote terminal and monitor with powerful easy-to-use software. From only \$2095

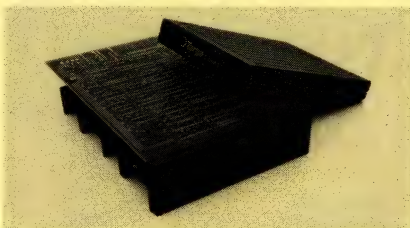
Call now for free data & demo disc

Ballard Technology

1216 N.W. 75th St.,
Seattle, WA 98117
(206) 782-8704

CIRCLE NO 755

NON-VOLATILE CARTRIDGE RAM DRIVE



MS-DOS FLOPPY DISK REPLACEMENT

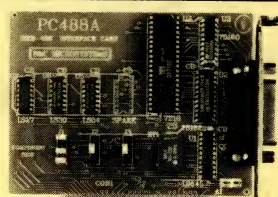
- Takes up no expansion slots
 - Acts like a disk drive — bootable
 - 360K, 720K, 1.2 Meg and 1.44 Meg Cartridges
 - Over 10 year battery life
 - Reliable solid state design — no moving parts
 - Connects directly to floppy disk controller in IBM and compatible computers; no drivers.
 - Two year warranty
- DRIVE, INTERFACE AND 360K — \$695;
with 720K — \$895**



Targa TARGA ELECTRONICS
SYSTEMS

TOLL FREE 1-800-267-9793

CIRCLE NO 756



PC488A \$145

LOW COST PC/XT/AT INTERFACE FOR IEEE-488 (GPIB/HPIB)

- Includes INSTALLABLE DOS DEVICE DRIVERS and software support for BASIC
- Optional language support for C, PASCAL, FORTRAN and ASSEMBLY — \$50
- Selectable base I/O address, IRQ and DMA
- CONTROLLER/TALKER/LISTENER capability
- Customer support via dedicated 24 hours B&C Microsystems BULLETIN BOARD
- Quantity discounts available

VISA MC AMEX

Call today for datasheet!!

B&C MICROSYSTEMS

355 West Olive Ave, Sunnyvale, CA 94086
PH: (408)730-5511 FAX: (408)730-5521 TELEX: 984185

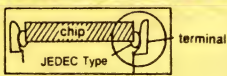
CIRCLE NO 757

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

TTC OFFERS HIGH QUALITY BUT LOW COST PRODUCTS.



Edge Card Connector



PLCC



SIMM Socket

SIMM is a Trade Mark of Wang's Laboratories.

1. SIMM Socket (Special design) - Single Row & Double Rows (Vertical & Angle) All can be stacked.
2. PLCC Socket - 28p. 32p. 44p. 52p. 68p. 84p.
3. Edge Card Connector; - 6p. 36p. 50p. 60p. 62p. 80p. 86p. 98p. 100p. 104p.
4. I.C Socket - 8p. 14p. 16p. 18p. 20p. 24p. 28p. 40p. 34p (16p & 18p can be changeable) - 4 Rows
5. Shunts (Mini Jumpers) - Open entry, close entry.
6. pin Headers: 2p-40p (Single Row or Double Rows Straight or right Angle)

TTC Shih Hsin Precision Corp.

Address: No. 284 JUN SHINN STREET, SHU-LIN TOWN, TAIPEI, TAIWAN, R.O.C.
TEL: 886-2-6894655, 6894656
TELEX: 33210 TTCCO FAX: 886-2-6894657

CIRCLE NO 758

Tango™ Sets The Pace!

Tango's ease-of-use, rich functionality and crisp output have brought *tens of thousands* of boards to life, quickly and affordably.



Start-to-finish design tools include:

Tango-Schematic With Library Manager,	\$495
Tango-PCB 1 mil Grid, 9 Layers, Gerber Output,	\$495
Tango-Route Autoroutes 90+%, Fast!,	\$495
Tango-Tools 8 Money-Saving Utilities,	\$295

Let's discuss *your* design needs Toll-Free, or order a full function Evaluation Pkg. just \$10. VISA/MC.

800 433-7801 619/695-2000
Satisfaction guaranteed.

ACCEL Technologies, 7358 Trade St., San Diego, CA 92121

CIRCLE NO 759

DSP ASAP \$1,995

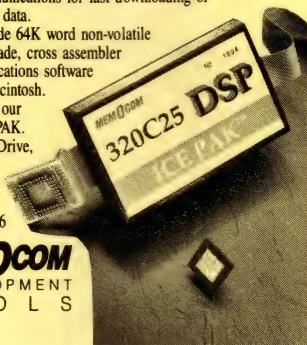
Drive your DSP design to market as fast as possible with our 320C25 in-circuit emulator.

The ICE PAK features real time emulation to 40 MHz, 16K words (35ns) program overlay memory, user definable break handler routine, single step trace, disassembler, and RS-232 communications for fast downloading of programs and data.

Options include 64K word non-volatile memory upgrade, cross assembler and communications software for PC or Macintosh.

Inquire about our 320C10 ICE PAK.
1301 Denton Drive,
Suite 204
Carrollton,
TX 75006
(214) 446-9906

MEMOCOM
DEVELOPMENT
TOOLS



CIRCLE NO 762

NEW CONTROL COMPUTER

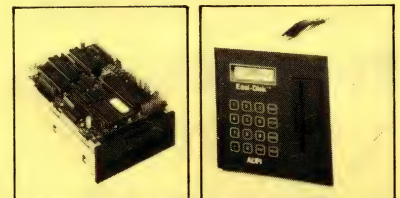


Our Multitasking Industrial Basic runs as fast as BASICA on the IBM PC/AT. It can also handle interrupts, frequency inputs, bit manipulation, datalogging and more. The hardware includes 4 channels of Analog with 12-bit resolution, 32 digital I/O lines, battery-backed calendar clock, keypad and display ports. 2 RS-232C serial ports, 96K RAM, EPROM and EEPROM programmers, autorun mode, low power CMOS circuitry, 8 MHz Z80 CPU. Only 4.5" x 8". Stand-alone or expandable. Low cost optional software turns your IBM PC into a program development workstation. FREE CATALOG describes other models and accessories. Call 303-426-8540 for same day response.

OCTAGON SYSTEMS CORPORATION 6510 W. 91st Ave.
Westminster, CO 80030

CIRCLE NO 760

IBM COMPATIBLE RS232/488 3 1/2 x 5 1/4" FLOPPY DATA STORAGE & TRANSFER SYSTEM



Information Transfer to/from Non IBM Compatible Systems to/from IBM & Compatibles: (Over RS-232 or 488 Interface).

- Reads & Writes MS DOS Disks
- RS-232/488 I/O
- Rugged Portable Package/battery option
- ASCII or Full Binary Operation
- Baud Rate 110 to 38.4K Baud
- 360K/720K RAM Cartridge Option
- Price \$895 in Singles—OEM Q'tys. \$495.

28 other systems with storage from 100K to 42 megabytes.



ANALOG & DIGITAL PERIPHERALS, INC.
251 South Mulberry St., Troy, Ohio 45373
P.O. Box 499 TWX 810/450-2685
513/339-2241 FAX 513/339-0070

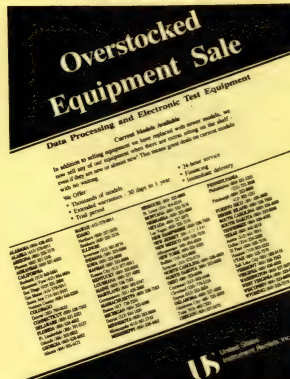
CIRCLE NO 763



smARTWORK® PCB Software. In a fraction of the time hand taping requires, you can create double-sided printed-circuit boards with smARTWORK and your IBM PC. The program's features include continual design-rule checking, automatic pad shaving, a silkscreen, and text for all three layers. smARTWORK with autorouting is \$895 (without, \$495) and comes with a 30-day money-back guarantee. Credit cards accepted. Write or call

Wintek Corporation
1801 South Street, Lafayette, IN 47904
(800) 742-6809 or (317) 742-8428

CIRCLE NO 764

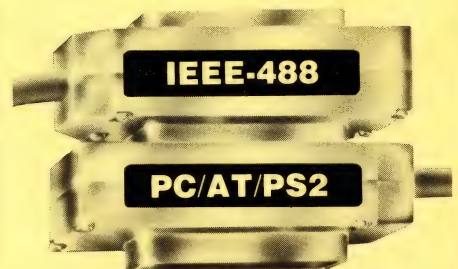


EXPERIENCED TEST EQUIPMENT

U.S. Instrument Rentals has overstocked equipment for sale. We have over 5,000 models of warranted equipment including MDS, analyzers, oscilloscopes, CAE/CAD workstations, power sources, meters, controllers, and recorders. Immediate delivery and financing available. For a free catalog of products and prices write or call

U.S. INSTRUMENT RENTALS, INC.
2988 Campus Drive, San Mateo, CA 94403-2563
(800) 824-2873

CIRCLE NO 765



GP-IB, HP-IB CONTROL FOR YOUR PC, PC/AT and IBM PERSONAL SYSTEM/2™

- Control instruments, plotters, and printers.
- Supports BASIC, C, FORTRAN and Pascal.
- Fast and easy to use. Thousands sold.
- Software library. Risk free guarantee.



Capital Equipment Corp.
99 South Bedford St.
Burlington, MA. 01803

FREE demo disk. Call (617) 273-1818

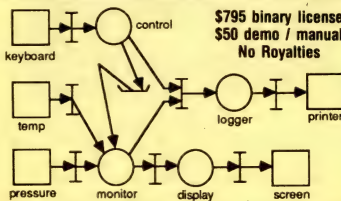
CIRCLE NO 766

To advertise in Product Mart, call Joanne Dorian, 212/463-6415

PCMASCOT

Real-Time Multitasking Kernel for your PC/XT/AT

Save development time utilizing this sophisticated software. Numerous applications including Data Acquisition, Process Control, Instrumentation, Communications, plus many more.



**\$795 binary license
\$50 demo / manual
No Royalties**

FEATURES:

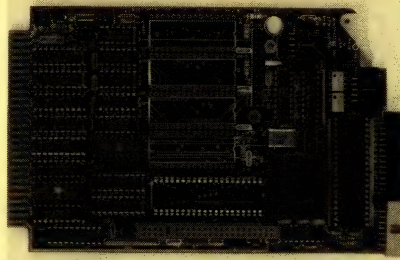
- Supports MASCOT design methodology
- Preemptive, priority-based scheduling • Interrupt management
- Synchronization and mutual exclusion • Shared data areas
- Intertask communications • Extensive debugging facilities
- Various language interfaces • Runs a standard DOS program

A highly qualified team of consultants can provide further services to assist you in applying PCMASCOT to your application.

Andyne Computing Limited
544 Princess Street, Suite 202
Kingston, Ont., CAN K7L 1C7
(613) 548-4355 1-(800) 267-0665



CIRCLE NO 767



CMOS STD BUS SINGLE BOARD COMPUTER

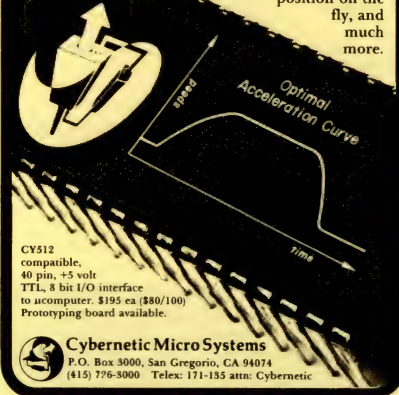
The LPM-SBC40 is a CMOS STD-BUS Single Board Computer that is designed for Industrial applications. The LPM-SBC40 uses the NEC V40 microprocessor, up to 256K bytes of EPROM, 384K bytes of battery backed-up SRAM, real time clock, two RS-232 serial channels with RS-422/485, watchdog timer and power fail logic, 5, 8 and 10 MHz.

WinSystems
Box 121361, Arlington, TX 76012
817/274-7553

CIRCLE NO 768

CY525 3rd generation STEPPER MOTOR CONTROLLER

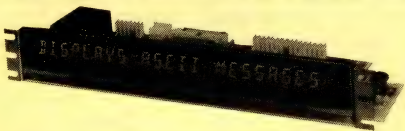
most intelligent controller offers linear ramping, 10,000 steps/sec, unlimited stepping, change rate on the fly, read position on the fly, and much more.



CY512 compatible, 40 pin, +5 volt TTL, 8 bit I/O interface to a computer. \$195 ea (\$80/100) Prototype board available.

Cybernetic Micro Systems
P.O. Box 3000, San Gregorio, CA 94074
(415) 776-3000 Telex: 171-135 atm: Cybernetic

CIRCLE NO 769



Programmable Controller Enhancer

Message Center is ready to install. Just plug it in . . . and read. Single line of 24, 1/2" high alphanumeric characters. Accepts parallel and serial ASCII inputs. Model W424-1051.

List price only \$385.40



CHERRY ELECTRICAL PRODUCTS

3600 Sunset Avenue • Waukegan, IL 60087 • 312-360-3500 • FAX: 312-360-3566

CIRCLE NO 770

UNIVERSAL LOGIC PROGRAMMER

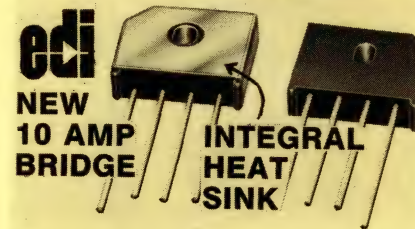
- PROGRAMS, READS, DUPLICATES, TESTS AND SECURES HUNDREDS OF 20- AND 24-PIN DEVICES
- 23 UNIVERSAL PIN DRIVERS WITH INDEPENDENT DAC, ADC & SLEW FUNCTIONS PROGRAM ALMOST ANY LOGIC DEVICE
- MENU DRIVEN OPERATION IS EASY TO LEARN AND QUICK TO OPERATE
- CONNECTS TO ANY IBM COMPATIBLE VIA PARALLEL PRINTER PORT
- EDITS FUSE DATA & TEST VECTORS WITH FULL SCREEN EDITOR
- TESTS WITH VECTORS & SECURES AFTER PROGRAMMING
- SUPPORTS ALL POPULAR PLD DEVELOPMENT SOFTWARE
- ONLINE HELP FUNCTION
- SELF CALIBRATING
- JEDEC FILE INPUT & OUTPUT
- 30 DAY MONEY BACK GUARANTEE
- EPROM PROGRAMMERS ALSO
- ONE YEAR WARRANTY
- SAME DAY SHIPMENT
- GOLD TEXT TOOL ZIF IC SOCKET
- UPDATABLE VIA FLOPPY
- TOLL-FREE TECH SUPPORT
- JUST \$798

CALL FOR FREE DEMO DISK OR INFO 800/225-2102

BP MICROSYSTEMS

10681 HADDINGTON #190 HOUSTON, TX 77043
713/461-9430 TLX: 1561477 FAX: 713/461-7413

CIRCLE NO 771



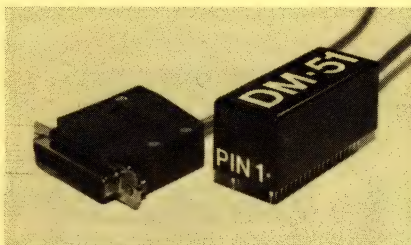
NEW 10A IN-LINE BRIDGE RECTIFIER

The Series 10PH in-line design features an aluminum heat sink and mounting hole that permits PC board or heat sink mounting. The rectifier provides the highest current capacity presently available in this case size. The model is available from 50 to 1,000 peak reverse volts, and 300 ampere surge. Recovery times to 50 ns. Case size is approximately 0.9 x 0.75 x 0.25 inches with 1 inch leads. For **FREE** SAMPLES, catalog sheet, and price information, contact

Electronic Devices, Inc.

21 Gray Oaks Ave., Yonkers, NY 10710
914-965-4400 800-678-0828

CIRCLE NO 772



DM-51: 8051 DIAGNOSTIC MODULE HARDWARE TROUBLESHOOTING TOOL

In-circuit tool for testing and trouble-shooting 8051 family based circuit boards. This completely self-contained, menu driven device connects to any Dumb Terminal or Computer serial port and provides instant detailed tests on: Bus problems, External Memory mapped devices, I/O functions, Interrupts, and more, for only \$385.

INNO-SOL CORPORATION
BOX 22201 MINNEAPOLIS, MN 55422
(612) 535-4556

CIRCLE NO 773

LEADER..... A Better Tomorrow For Transformer Through Automation



CONTACT US RIGHT NOW!



LEADER ELECTRONICS INC.

No.2, Lane 87, Pao Hsin Rd.,
Hsin Tien, Taipei, Taiwan, R.O.C.
Cable: :LEADEREL TAIPEI
Telex: 31372 LEIGROUP
Fax: 886-2-917-6809
Tel: 886-2-911-1910 (Rep)

CIRCLE NO 774

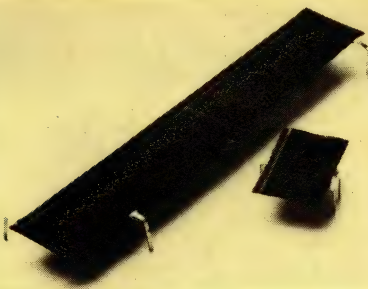
Digital Control Intro \$200
Digital Filter Tutor \$450
Kalman Filter Tutor \$925

Practical hands-on training courses that run on the IBM PC. Ideal alternative to text books, seminars, and university courses. **FREE** demo disk available.

Engineering Tutorial Software
22338 Lull Street
Canoga Park, CA 91304
(818) 716-0816

CIRCLE NO 775

To advertise in Product Mart, call Joanne Dorian, 212/463-6415



SOLVE DECOUPLING PROBLEMS

MICRO/Q 1000 capacitors with special pinout configurations give superior noise suppression, design ease. Solve special decoupling and routing problems for 8, 16, 32-bit microprocessors, and other devices where power and ground are not in conventional positions.

Rogers Corp. 2400 S. Roosevelt St., Tempe, AZ 85282 602/967-0624

CIRCLE NO 776



UNIVERSAL E(E)PROM PROGRAMMER \$495 (Kits from \$165)

- No personality modules; Menu driven device selection.
- Built-in Eraser/Timer option (\$50); Conductive foam pad.
- Direct technical support; Full 1 year warranty.
- Stand alone duplication & verify (27XX parts).
- Quick pulse algorithm (27256 under 60 sec).
- 27xx to 1 Mbit; 25xx; 68xx; CMOS; EEPROMS.
- 8741, -2, -4, -8, -8H, -9, -9H, -51, -C51, -52, -55, 9761 & more.
- IBM-PC, Apple, CPM or Unix driver; Autobaud RS232.
- Offset/split Hex, Binary, Intel & Motorola 8,16,32 bit.
- Manual with complete schematics.

VISA MC AMEX Call today for datasheets !!

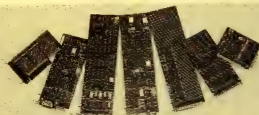
B&C MICROSYSTEMS

355 WEST OLIVE AVE. SUNNYVALE, CA 94086
PH: (408) 730-5511 FAX: (408) 730-5521 TELEX: 984185

CIRCLE NO 777

INDUSTRIAL I/O CARDS

Lab, Industrial, and Engineering I/O cards for IBM PC/XT/AT



High Performance Data Acquisition Card (Model 718)

- emulation of many traditional instruments like digital oscilloscope, X-Y recorder, strip chart recorder, data logger, programmable controller, etc. Functions include: A/D converter (16 single-ended or 8 differential input channels, 12 bit resolution, 60,000 samples/sec. various input range), D/A converter (20/D/A channels), Digital I/O (16 input & output channels, TTL compatible level), Counter/Timer (Intel 8254, 16 bit programmable counter) (Metabyte S/W compatible, optional 100,000 samples/sec.) \$895

Other Lab Cards are available.

12 bit Multi-Lab (Model 712); A/D, D/A, DIO, Counter \$295

14 bit Super-Lab (Model 714); A/D, D/A, DIO, Counter \$495

Prototype Development Card (Model 750); 3290 holes, \$70

built-in basic circuit, independent memory, I/O jumper

IEEE-488 Interface Card (GP18) (Model 748) \$395

On board RAM working space, BASICA & BASIC supported. Powerful

easy-to-use software command set. C & Pascal optional.

We also have Digital I/O and Counter Card, Relay Actuator & Isolated D/A Card, RS-422

Card, Stepping Motor Controller Card, XT/AT Slot Extension kits, AMP/MUX Board, and more and more.

Call us for details and turn-key application S/W package works with

above data acquisition cards.

(TEL) 408-727-6995

(Technical)

1-800-541-1975

(Orders only, outside CA)

(FAX) 408-727-6996

VISA OR M/C

CIRCLE NO 780

IEEE-488 CONTROLLER FOR PS/2

MODELS 50, 60, 80

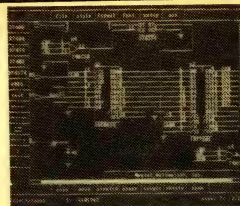
- GPIB Compatibility
- Control Up to 14 Devices
- Selectable Addressing
- Software Included

1-800-553-1170



478 E. Exchange St., Akron, OH 44304
TEL: (216) 434-3154 FAX: (216) 434-1409
TLX: 5101012726

CIRCLE NO 783



SuperCAD™

Schematic entry Software for the IBM® PC & Compatibles ONLY

\$99.00

COMPLETE PACKAGE

- ★ Easy-to-use schematic entry program for circuit diagrams, visible on-screen and pulldown menus
- ★ Supports popular graphic standards, mouse and printers
- ★ Powerful editing and drawing commands, including automatic drawing of digital busses
- ★ Extensive digital, analog and discrete part libraries (Over 1,000 parts!)
- ★ In-depth, readable instruction manual has many examples and illustrations
- ★ Software includes part building, netlisting, design rule checking and bill of materials programs

Write or call for demo disk:

MENTAL AUTOMATION, INC.

ORDERS/INFORMATION:

Send check or money orders to:

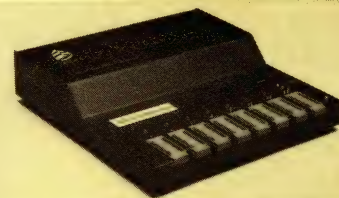
Mental Automation, Inc., Dept. S-9, 5415 136th Place S.E.,

Bellevue, WA 98006 or call (206) 641-2141

Visa/MasterCard orders accepted!

Dealer inquiries welcomed.

CIRCLE NO 778



SAILOR PROGRAMMERS:

#1 IN SOFTWARE, #1 IN SPEED

Software driven by IBM PC/XT/AT/PS2. Rugged, industrial quality. 1-2-3 style user interface. Interactive plus automatic batch operation. Beloved by our customers.

Sailor-2,-8: 2/8-socket set/gang high speed EPROM programmers, to Mbit devices. High speed parallel interface to PC means no waiting for download. Virtual memory feature means no RAM modules ever required. \$575-\$975.

Sailor-PAL: Supports PLDs, EPROMs, PROMs: Bipolar, CMOS, EPD, GAL, PEEL, ECL and Signetics PLS. \$1095-\$1895.

ADVIN SYSTEMS, INC.

1050 East Duane, Sunnyvale, CA 94086

408-984-8600

TLX 5106005624 FAX: 408-245-2135

CIRCLE NO 781

Analog Circuit Simulation

NEW

IS_SPICE/386
\$386.00

Runs on 386 PC's in protected mode with DOS 3.1 & up. Uses 287, 387 or W1167 coprocessor

- **IS_SPICE, \$95.00:** Performs AC, DC and Transient analysis; runs on all 80786 PC's in real mode.
- **PRE_SPICE, \$200.00:** Adds Monte Carlo Analysis, Sweeps, Optimization, libraries and algebraic parameter evaluation.
- **Intu_Scope, \$250:** A graphics post processor works like a digital oscilloscope. Easy to use with all the waveform operations you will ever need.
- **SPICE_NET, \$295:** Schematic entry for any SPICE simulator. Automatically makes a SPICE net list and places Intu_Scope waveforms on your schematic.
- **30Day Money Back Guarantee**

intusoft

(213) 833-0710

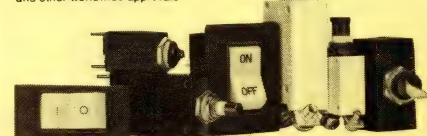
P.O. Box 6607

San Pedro, CA

90734-6607

CIRCLE NO 782

NEED CIRCUIT PROTECTION?



E-T-A has "THE RIGHT STUFF!"

- Commercial, Mil & Low Cost Types • Magnetic or Thermal • 0.05 to 400 A, 250V AC or 28V DC
- ON/OFF Switch/Breaker Combination • PC Board & Snap-in Mounts

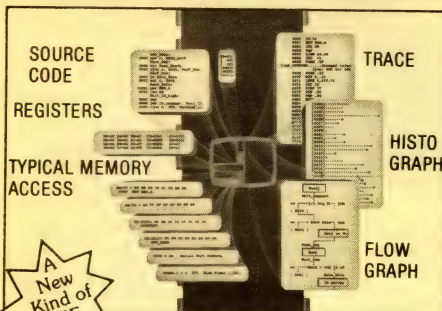
E-T-A®

CIRCUIT BREAKERS

7400 North Crounse Road, Chicago IL 60648 • 312/647-8303

CIRCLE NO 784

To advertise in Product Mart, call Joanne Dorian, 212/463-6415



A New Kind of ICE

dICE-51 only \$595

8051 Debugger with In-Circuit-Element

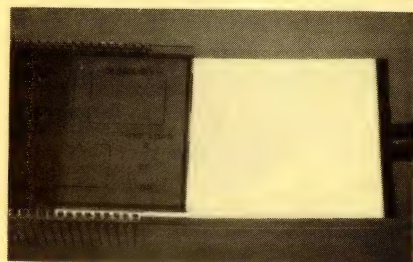
The CY-8051 in-circuit element replaces the 8051 and communicates with your IBM-PC over COM1. The powerful dynamic user interface provides source code and symbolic debugging with easy access to all 8051 spaces. Live keyboard, Global Symbol Monitor, 'C' support. Histogram generated during reduced speed execution. Lowest cost, most powerful 8051 design support. Mil spec and CMOS versions available.



Cybernetic Micro Systems, Inc.

Box 3000 • San Gregorio, CA 94074 • USA
(415) 728-3000 • Telex: 910-350-5842

CIRCLE NO 785



EL LCD BACKLIGHTING.

To backlight or not to backlight? With BKL's EL lamps, the answer is simple, inexpensive and fast! BKL's extremely thin (.012" to .018") quality lamps are made from Kard-O-Lite, a patented electroluminescent material that's easily die-cut to any size, any shape. For the fastest turnaround in the industry, at a drastically reduced cost, call Dean Smith, 215-277-2910.

BONAR KARD-O-LITE™

421 Feheley Drive
King of Prussia, PA 19406
(215) 277-2910

CIRCLE NO 788

Only a Specialized Manufacturer Could Provide Versatile and Economic Products

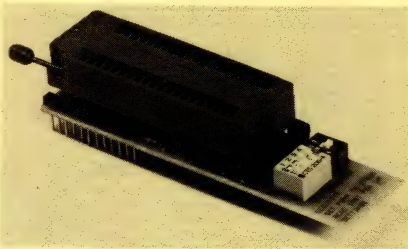


With more than 11 years' experience in this field, we proudly offer you various types of conductive silicone rubber pads, rubber pads with multicolor and screen printing, silicone rubber overlay, rubber pads with screen printing on plastic keytops, O rings, washers, inner caps, tubes, etc., and screen printing flexible circuit boards. Please contact us for more information.



GENERAL SILICONES CO., USA
650 W Duarte 305, Arcadia CA 91006, U.S.A.
Tel: (618) 445-8836 Telex: 3716189 GSCUI.
Fax: 618-4456084

CIRCLE NO 786



87C51 PROGRAMMER \$125

The UPA87C51 converts general purpose programmers to 8751/87C51 programmers. Select 2732A on your programmer, plug in the UPA, and you have an 8751/87C51 programmer. With the UPA87C51 you can also program the 8751 and 87C51 security bits and the 87C51 encryption array. It's very simple and VERY cost effective.

Price \$125.00 including UPS ground shipping. Adapters are also available for the 63701V0, 63705V0 and 8751 and are priced at \$65.-\$95.

Logical Systems Corp.

PO Box 6184 Syracuse NY 13217-6184 USA
(315) 478-0722 Telex 6725617 LOGS
FAX (315) 475-8460

CIRCLE NO 789

TIGER POWER

40-350W range of switching power supplies

Model: BM-2150
(Mini Tiger)



Lead Year's main SPS products are:

- PS/2 models
- 386 tower models
- 286/386-type PC/AT models
- Mini Tiger' super compacts
- Cubic Baby AT models
- PC/XT models
- OEM are welcome



E-97155
U.S.A.



LA 65589
CANADA



R60200
W.G.



SEMIKO
SWEDEN



FMCBHM
U.S.A.



FTZ
W.G.

Contact us today for more information on how Lead Year's Tiger Power make your electronics great!



Lead Year Enterprise Co., Ltd.

3F, No. 481, Chung Hsiao E., Rd., Sec. 6,
Taipei, Taiwan, R.O.C.

TIGER POWER P.O. BOX 53-352 Taipei Tel: 886-2-7857858

Tlx: 10862 LEADYEAR Fax: 886-2-7857852

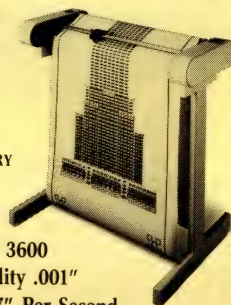
PC/XT, PC/AT, Baby AT and PS/2 are trademarks of the International Business Machines Corp.

CIRCLE NO 787

"D" SIZE PLOTTER

\$2295⁰⁰
RETAIL

\$1695⁰⁰
INTRODUCTORY
OFFER



- Model PC 3600
- Repeatability .001"
- Speed at 7" Per Second
- Vacuum Paper Hold Down
- High Resolution Circles: Suitable for PCB Artwork

(415) 490-8380 **ZERICON**
STEVENSON BUSINESS PARK
BOX 1669 • FREMONT, CA 94538

CIRCLE NO 790

Fill out this form to advertise in Product Mart.

EDN081886

ISSUE(S) REQUESTED _____

RATE:	1x	4x	7x	13x	19x	26x	39x	52x
(Please circle)	\$ 780	750	730	660	640	630	620	595

Company _____

Address _____

City _____ State _____ Zip _____

Telephone _____

Signature _____

AD ENCLOSED ☐

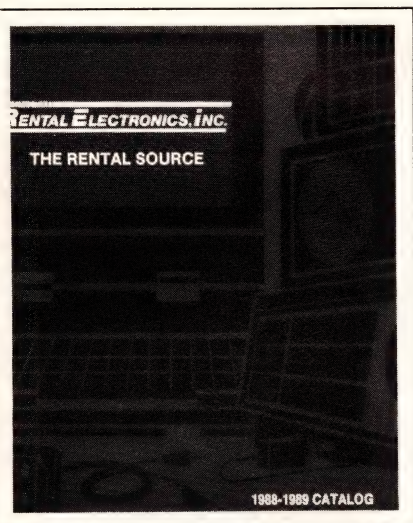
AD TO FOLLOW ☐

Mail to: EDN / 275 Washington Street / Newton, MA 02158-1630

EDN PRODUCT MART appears in every issue — 26x a year!

**ADVERTISE
IN
PRODUCT
MART
AT
LOW COST**

To advertise in Product Mart, call Joanne Dorian, 212/463-6415



Listing of electronic test equipment for rent

This 1988-89 Rental Catalog presents electronic test equipment that's available for rent. The 36-pg listing includes products from major instrumentation manufacturers, such as Hewlett-Packard, Tektronix, Intel, and Fluke. The instru-

ments for rent fall into 26 categories, including analyzers, meters, generators, oscilloscopes, desktop computers, and telecommunications. Rental terms and conditions, illustrations, and a product index complete the publication.

GenStar Rental Electronics Inc., 6307 DeSoto Ave, Suite J, Woodland Hills, CA 91367.

Circle No 450

Catalog unveils software for VAB and HP-UX

The vendor's 200-pg Publication 5951-6794 deals with software for value-added-business (VAB) and proprietary-software solutions for its HP-UX operating system. The catalog lists more than 400 technical and commercial software packages for the vendor's HP-9000 workstations and servers. Using the market keyword index, you can look for products in specific application

areas. A range of application areas are available, from aerospace simulators to water-utilities operation. Business application areas include financial management, sales analysis, and accounting packages. The 200 VAB software packages listed in the publication are part of the HP Plus Program that assists third-party software suppliers with marketing the products.

Hewlett-Packard Co., Customer Information Center, Inquiry Fulfillment Dept, 19310 Pruneridge Ave, Cupertino, CA 95014.

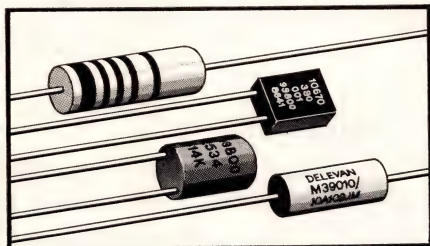
Circle No 451

Survey analyzes repair record of personal computers

The report, *Opportunities in Personal Computer Servicing: A National Survey of Malfunction and Repair*, is the second in a series of analyses outlining the personal-computer industry. It provides an

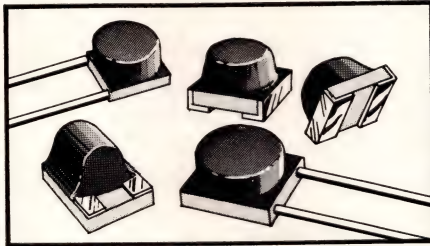
ON BOARD RELIABILITY BEGINS WITH MIL SPEC COILS & INDUCTIVE COMPONENTS

PRECISION COILS NEWLY QUALIFIED MIL C-39010/8,9,10



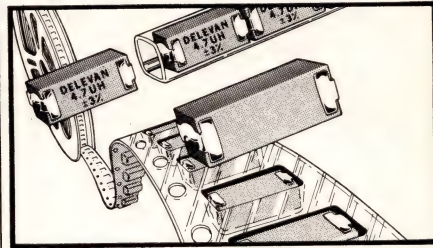
- Qualified for MIL-15305
- 1%, 3% tolerance for unshielded 0.022 μ H to 10,000 μ H
- 5% tolerance for shielded 0.1 μ H to 10,000 μ H
- Toroids & power chokes
- Custom designs

MICRO-i® & CHIP INDUCTORS FOR HYBRID APPLICATIONS



- Qualified to MIL C-83446/4 and MS 21367
- 5% Tolerance Available
- Chips, wire bondable ribbon leads or reflow solder pads
- .010 μ H to 1,000 μ H

CUSTOM ENGINEERED SURFACE MOUNTABLE COILS & INDUCTORS



- Military approval pending MIL 83446
- 1%, 3% tolerance for unshielded matched parts
- 0.022 μ H to 1,000 μ H
- 5% tolerance for shielded parts
- 0.1 μ H - 560 μ H
- Reel taped for pick & place

PLUS ... Dependable performance, quality & delivery/Bulk or tape packaging/laser marking available/Nationwide distribution network. Call or FAX us for details.

MADE IN AMERICA BY AMERICAN CRAFTSMEN
TO AMERICAN STANDARDS OF EXCELLENCE

270 Quaker Road, East Aurora, NY 14052-0449 (716) 652-3600 FAX (716) 652-4814



DELEVAN / SMD Divisions
AMERICAN PRECISION INDUSTRIES
Electronic Components Group

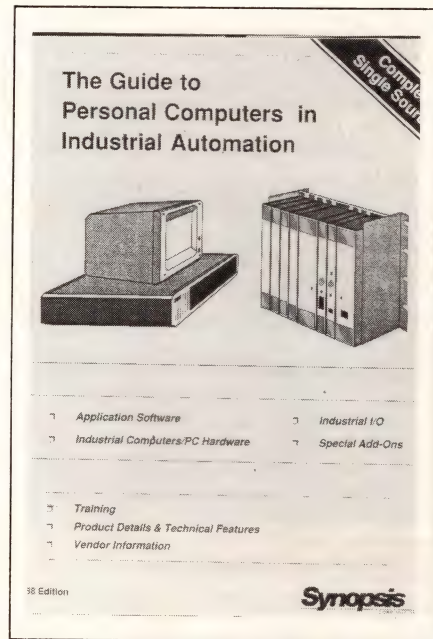
overview of personal-computer hardware and its failure rate, and evaluates the responses of almost 500 business-oriented respondents, concerning product failure, repair, and service contracts. \$299.

Business Products Consulting Group, 24 Fort Salonga Rd, Centerport, NY 11721.

INQUIRE DIRECT

Guide to personal computers

The 2nd edition of *The Guide to Personal Computers in Industrial Automation* is a comprehensive single-source reference for the use of IBM-compatible and Macintosh personal computers. The 102-pg guide lists 700 products from 300 vendors, representing major applications and



technology. Entries include application software, PC hardware, industrial computers, industrial I/O devices, and peripherals. The guide also provides applications in process monitoring and control, data acquisition, PLC (programmable logic controller) programming/documentation, statistical quality control, manufacturing resource planning, operator interface, and cell control. A training section provides application training and technology reviews that include charts, photos, and diagrams. \$39.95.

Synopsis Corp., 2708 Salisbury Plain, Raleigh, NC 27612.

INQUIRE DIRECT

IC data book

This company's 1988 data book presents all of the information found in the 1987 issue, as well as technical specifications and application notes for all the company's products released during the past year. It also features previews of many products to be released during 1988. New sections describe electrostatic discharge sensitivity and provide information about the sale of products in die form.

Elantec Inc., 1996 Tarob Ct, Milpitas, CA 95035.

Circle No 452

Turn Good Ideas Into Good Articles

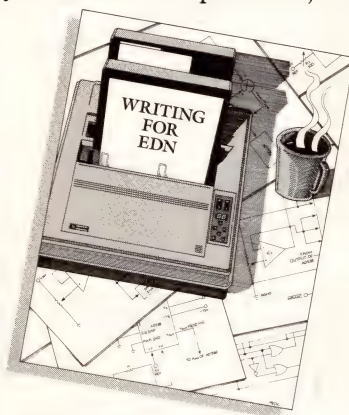
With EDN's FREE Writer's Guide!

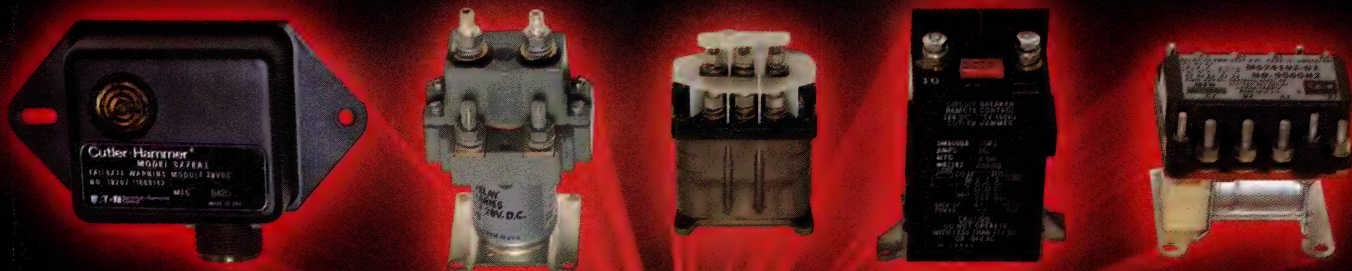
Would you like to get paid for sharing your clever engineering ideas and methods with your professional colleagues? If so, then send for EDN's new FREE writer's guide and learn how.

You don't need the skills and experience of a professional writer. And you don't need to know publishing jargon. All you *do* need are a little perseverance, your engineering skills, and the ability to communicate your ideas clearly.

Our new writer's guide takes the mystery and intimidation out of writing for a publication. It shows you how to write for EDN using skills you already have. Plus, it takes you step-by-step through the editorial procedures necessary to turn your ideas into polished, professional articles.

Get your *FREE* copy of EDN's writer's guide by circling number 800 on the Information Retrieval Service Card or by calling Sharon Gildea at (617) 964-3030.





Aerospace Relays



Cutler-Hammer® aerospace relays meet a wide range of MIL-SPEC applications!

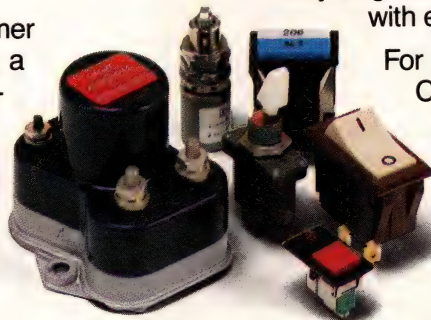
For years, design engineers have relied on Cutler-Hammer aerospace relays to meet their military specification design needs.

That's because each Cutler-Hammer relay is backed by extensive R&D; a worldwide, well-structured distribution network and knowledgeable, professional service.

Count on Cutler-Hammer aerospace relays to fit neatly into your design plans. Choose from an

extensive line of power and hybrid relays, including: hermetically sealed and non-sealed power relays, lightweight power relays and hybrid relays with electronic/electrical capabilities.

For more information, contact your Cutler-Hammer sales office or distributor. Or send for our complete catalog. Eaton Corporation, Aerospace & Commercial Controls Division, 4201 N. 27th St., Milwaukee, WI 53216. Or call 414-449-7487.

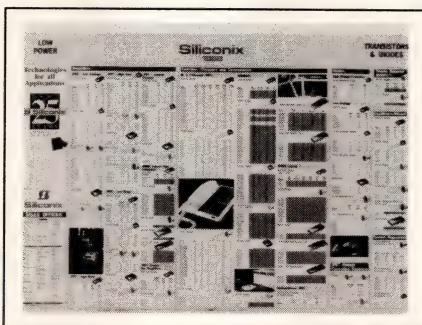


Aerospace, Commercial, Miniature, Illuminated Switches and Relays.

EAT•N

Visual aid helps you choose the best FET

This 22×32-in. wall chart helps you in the selection of the most suitable FET for your design—whether it's a low-leakage/low-noise JFET, an ultrahigh-speed DMOS FET, or a low-power MOSFET. The chart also includes specifications for the vendor's most popular low-power discrete

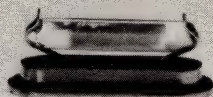
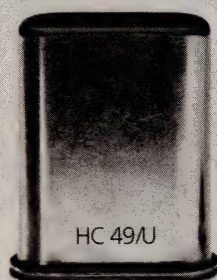


FETs. For easy reference, the chart is organized by major circuit categories, such as amplifiers, switches, choppers, commutators, diodes, current regulators, oscillators, mixers, and voltage-controlled resistors. Within each application area, the parts are sorted according to selection criteria—for example, amplifier FETs are sorted by critical parameters and by package options.

Siliconix Inc., 2201 Laurelwood Rd., Santa Clara, CA 95054.

Circle No 453

NDK AT-51: Highest quality with a low profile.



Specifications

- Frequency range: 3.579545 MHz: 20.000 MHz
- Frequency tolerance: ±20 ppm at 25°C
- Operating temperature range: -10°C to 60°C
- Frequency stability in operating temperature range: ±30 ppm over -10°C to 60°C
- Aging: 5 ppm/year
- Vibration: MIL-STD 202F method 207 Condition E
- Shock: 1500G 0.5 MSEC half sinewave 3 times in each of 3 planes
- Solderability: MIL-STD 202E method 208C

ACTUAL SIZE



NDK AT-51 MINIATURE MICROPROCESSOR CRYSTAL

NDK's AT-51 miniature cut strip crystal is a tower of power in a very low profile package. This microprocessor crystal is less than half the size of equivalent units, yet holds the same footprint. The result is better economy of board space without the need to redesign. Additionally, the AT-51 has a wide frequency range, higher resistance to shock and vibration and can be used as a plug-in replacement for HC 49/U type standard crystals. And the best news is that each part is backed by the NDK commitment to quality.

NDK: YOUR SINGLE SOURCE

NDK offers the widest range of compact crystal oscillators, microprocessor quartz crystals, and standard crystal oscillators available. All fully guaranteed to be free from impurities and defects. And all available through NDK's nationwide network of stocking distributors.

For a free product catalog, or to order evaluation samples, contact NDK today.

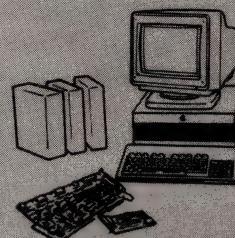


NDK America, Inc.

20300 Stevens Creek Blvd., Suite 400, Cupertino, CA 95014-2210
Telephone: (408) 255-0831 Telex: 352057 NDKCOLTO QTO
Fax: (408) 725-0369

The PC Technical Source-Book

for Engineers, Scientists and
Other Serious PC/XT and PC/AT Users



1988 Edition

A Collection of Hardware and Software
Facts and Data on the IBM PC Family
and Its Operating System

By
Industrial Computer Source

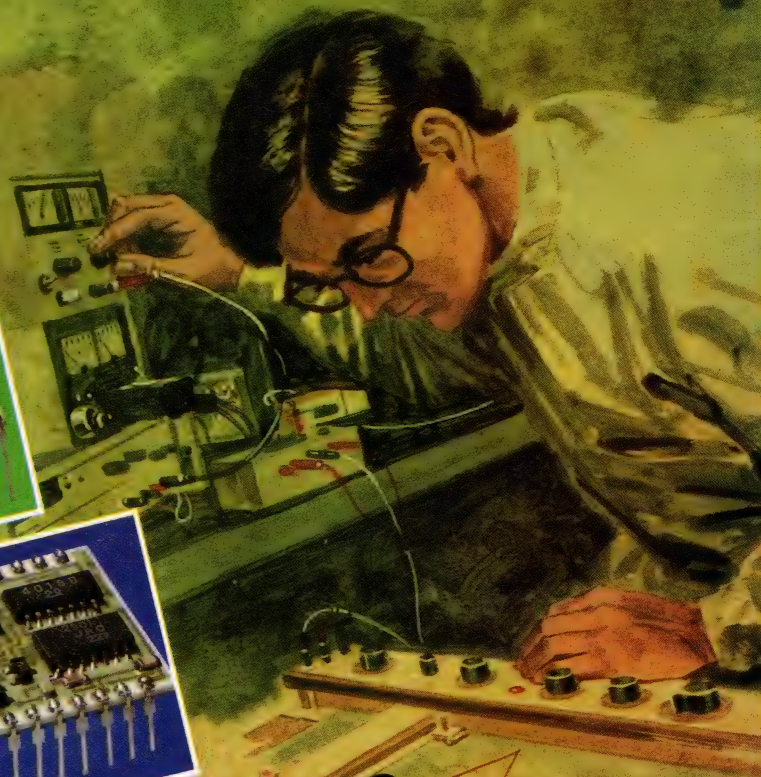
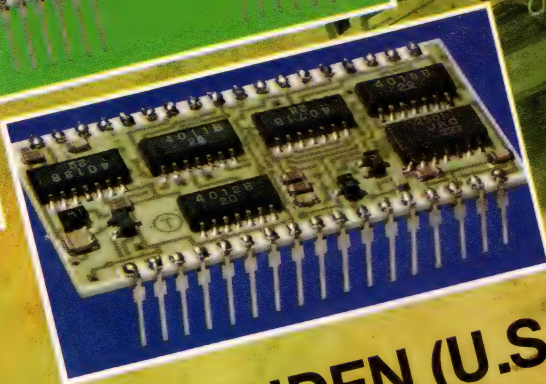
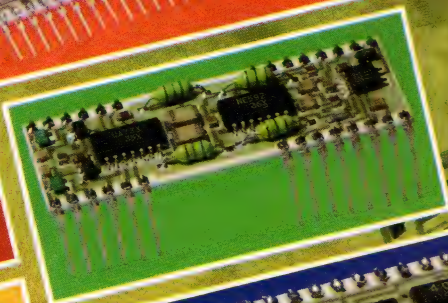
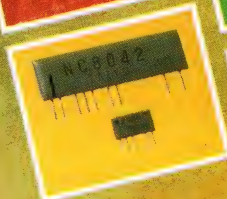
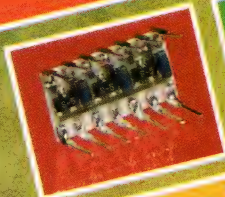
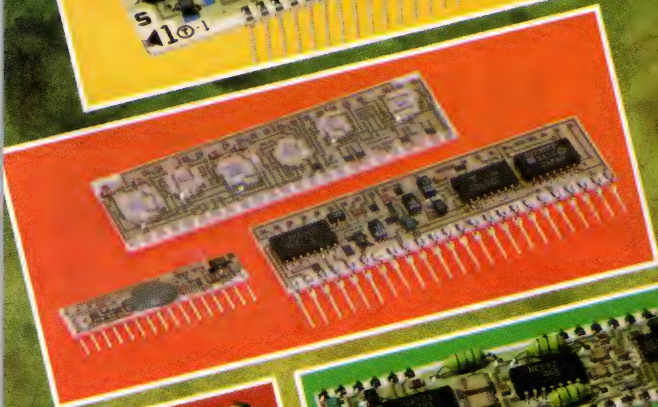
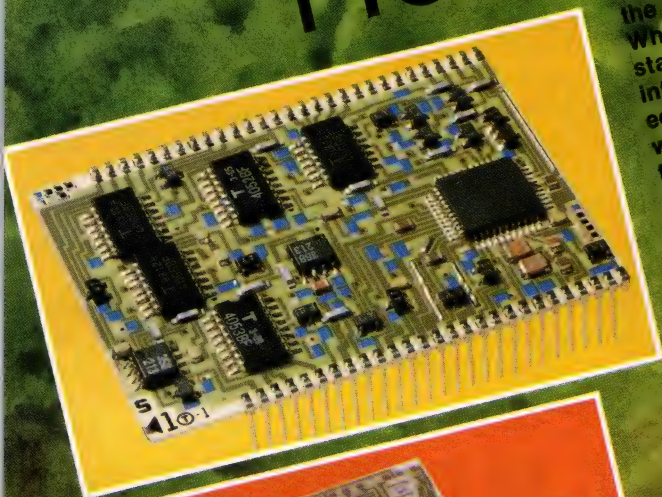
Manual targets IBM PC/XT and PC/AT users

Aimed primarily at engineers, scientists, and other professional IBM PC/XT and PC/AT users, *The 1988 PC Technical Source-Book* is a collection of hardware and software facts and data about the IBM PC family and its operating system. The 76-pg manual provides an introduction to the IBM PC for the beginner and a ready reference for the experienced user. It includes among its topics: I/O Bus 62-Pin Connectors, Bus Signal Summary, Memory Map, I/O Map, DMA Channels, Switch Settings, and DOS Commands. Further topics are AT CMOS Memory, 8237 DMA Controller, Keyboard Scan Codes, IBM PC/XT and PC/AT I/O Card Dimen-

Hybrid Reliability Begins Here

Whether you're producing...computers...computer peripherals...telecommunications...medical equipment...terminals...office machines...or NC machine tools...Taiyo Yuden hybrid circuits are your best investment in reliability. **Why?** The reason is simple. In thick film hybrids, design, manufacturing and rigid testing is critical. Taiyo Yuden - **with almost 50 years in electronics** - is the international leader in hybrid circuit assembly. Whatever your requirements, our U.S.-based engineering staff will work with you to transform your hybrid design into a working product incorporating the latest in leading-edge technology, with the same high quality components they're available at very competitive prices. To find out more about Taiyo Yuden hybrids, write or call today:

TAIYO YUDEN (U.S.A.) INC.
714 West Algonquin Road
Arlington Heights, IL 60005
Tel: 1-312-364-6104
Telex: 910-687-0378 TAIYO U.S.A. ARHT



TAIYO YUDEN (U.S.A.) INC
714 West Algonquin Road • Arlington Heights, IL 60005
Tel.: 1-312-364-6104 • Telex: 910-687-0378 TAIYO U.S.A. ARHT

CIRCLE NO 227

sions, and Hex and Decimal Equivalents.

Industrial Computer Source, 5466 Complex St, Suite 208, San Diego, CA 92123.

Circle No 454

Studies deal with AI in electronics manufacturing

These three case studies discuss the use of artificial intelligence in electronics manufacturing. The 336-pg *Artificial Intelligence Applications in Manufacturing* presents more than 200 commercial expert systems and case studies for specific applications such as CAD/CAM, maintenance, production scheduling, and energy management. The 198-pg *Artificial Intelligence in the Computer/Electronics Industry* explains the aspects of AI used for in-house applications: expert systems, artificial vision, voice recognition, and intelligent robots. Finally, the

176-pg *Artificial Intelligence in the Semiconductor Industry* discusses the research being done by major manufacturers in the design of VLSI circuits. Each publication costs \$135.

Lion Publishing, Box 1869, Los Gatos, CA 95031.

INQUIRE DIRECT

Publications clarify ADC and TDC systems

This technical data sheet and application note explain the FERA/FERET fast-encoding and readout data-acquisition systems. The 4-color, 8-pg data sheet details the features of these modular systems and describes units for fast A/D conversion (Model 4300B), time-to-digital conversion (Model 4303), and fast access memory (Model 4302). It also reports on modules that provide logic decisions based on analog and time information. The application



note, *FERA/FERET-Fast Encoding and Readout ADC/TDC Systems (AN 4004A)*, presents the systems, using text, tables, and diagrams, and discusses several configurations.

LeCroy Corp, 700 Chestnut Ridge Rd, Chestnut Ridge, NY 10977.

Circle No 455

SUPPLYING MOBILE ELECTRONICS IS NO LONGER A QUESTION OF SOURCE VOLTAGE



There's only one DC/DC converter covering the whole range of source voltages available on airplanes, boats, trucks and many other transport vehicles!

DC/DC Converters Series A/B/CM and B/CSR

- Input range 7 to 140 VDC for 12, 24, 36, 48, 60, 72 and 110V-batteries covered by one single module
 - Input transient protection
 - Very low RFI level; A/B, VDE 0871
 - Isolation 2.5kV_{eff}
 - High efficiency, up to 84%
 - Up to 3 outputs with 20 to 50 W
 - T_A-40 to +70°C without derating
 - Rugged and compact design in 6-side shielded aluminum case
 - MTBF 120,000 hrs at T_A 40°C
- Identical units with 88 to 372 VDC and 90 to 264 VAC inputs available.

SUPPLYING GREAT PERFORMANCE:

MELCHER



MELCHER AG, CH-8610 Uster/Switzerland, Ackerstr. 56, Tel. 01-941 37 37
MELCHER INC., Natick, MA 01760, 10 Cochituate Str., Tel. 508 653 9979

We Wrote The Book On Switches!



Update your switch source file with C&K's new free catalogs. The Newton Division Products Catalog #8709 includes miniature instrument grade toggle, rocker, slide, DIP, pushbutton, rotary and thumbwheel switches. The Clayton Division Products Catalog #C8803 includes switchlocks and low cost slide, rotary, rocker and pushbutton switches.

Send for our new free catalogs and see how we wrote the book! To receive a free sample, call (617) 964-6400. FAX (617) 527-3062

C&K[®] C&K Components, Inc.
15 Riverdale Avenue
Newton, MA 02158-1082

The Primary Source Worldwide[®]...

SEE US AT MIDCON, BOOTH #630-634

Document examines dc/dc converters and amplifiers

This 32-pg booklet of application notes defines technical terms for dc/dc converters. It includes a users' guide that tells you how to make accurate measurements; and about the effects of regulation, input noise, common-mode noise, and load-induced noise. Notes on *input*

ripple rejection provide instructions for building a low-power noise test fixture and thermal-design calculations. Other sections, which include illustrations of 25 performance-type curves and 45 diagrams, instruct you in the use of a dc/dc converter as an ATE supply; in the use of a dc/dc converter in parallel for more power; in using instrumentation am-

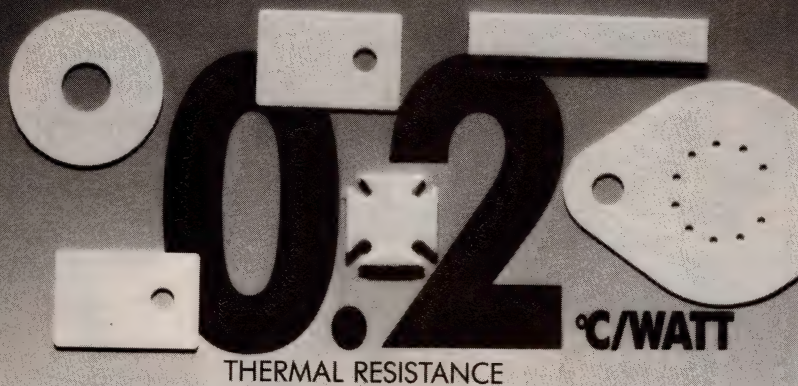


plifiers, and in grounding and shielding amplifiers.

Calex Mfg Co Inc, 3355 Vincent Rd, Pleasant Hill, CA 94523.

Circle No 456

YOUR BEST DEFENSE AGAINST HEAT



NEW! SIL-PAD 2000®

The Thermally Conductive Insulator for High Performance, High Reliability, Military/Aerospace Applications

SIL-PADS have earned their stripes in the battle against heat. With 0.2°C/watt* thermal resistance and breakdown voltage of 4,000 volts, SIL-PAD 2000 can handle your toughest heat problem.

For demanding military/aerospace applications SIL-PAD 2000 meets Mil-I-49456, the specification governing elastomeric fiberglass sheet insula-

tion material. SIL-PAD 2000 is a boron-nitride loaded silicon elastomer. It's "grease-free," conformable and it's capable of meeting or exceeding the thermal and electrical requirements of high reliability applications.

SIL-PAD 2000 is available in a variety of thicknesses, in standard configurations or custom shapes.

*.17°C/watt, 10 mil thickness.

Contact Bergquist today for free samples and a copy of the SIL-PAD Design Guide. Call Toll-Free 1-800-328-3882

BERGQUIST

5300 Edina Industrial Blvd. • Minneapolis, MN 55435
Telephone: (612) 835-2322 • TWX: 910-576-2423 • FAX: (612) 835-4156

STANDARD CONFIGURATIONS

ROGERS PART	THICKNESS (MILS)	W x L (IN)	W x L (MM)	W x L (IN)	W x L (MM)	W x L (IN)	W x L (MM)
ROGERS-0001	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0002	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0003	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0004	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0005	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0006	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0007	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0008	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0009	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0010	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0011	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0012	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0013	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0014	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0015	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0016	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0017	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0018	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0019	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0020	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0021	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0022	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0023	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0024	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0025	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0026	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0027	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0028	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0029	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0030	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0031	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0032	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0033	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0034	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0035	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0036	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0037	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0038	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0039	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0040	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0041	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0042	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0043	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0044	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0045	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0046	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0047	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0048	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0049	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0050	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0051	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0052	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0053	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0054	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0055	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0056	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0057	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0058	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0059	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0060	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0061	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0062	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0063	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0064	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0065	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0066	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0067	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0068	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0069	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0070	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0071	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0072	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0073	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0074	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0075	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0076	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0077	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0078	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0079	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0080	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0081	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0082	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0083	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0084	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0085	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0086	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0087	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0088	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0089	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0090	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0091	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0092	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0093	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0094	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0095	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0096	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0097	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0098	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0099	10	1.00	1.00	25.4	25.4	1.00	1.00
ROGERS-0100	10	1.00	1.00	25.4	25.4	1.00	1.00

Data sheet deals with decoupling capacitors

This data sheet examines the vendor's Micro/Q decoupling capacitors. It gives you product specifications, standard and special configurations, and electrical performance. Finally, it provides installation and ordering information.

Rogers Corp, Circuit Components Div, 2400 S Roosevelt St, Tempe, AZ 85282.

Circle No 457



Selecting or Specifying ICs or Discrete Semiconductors?

**We'll help you
get the work out...**

without the workout.

If you spend time working with IC or Discrete semiconductors, you should get to know our DIGESTs. Because they can make your work go a whole lot easier.

Quickly compare electrical specs, packages, pinouts; find alternate sources or replacement information; or go directly from generic or part numbers to technical and manufacturer data. All at your fingertips...your own personal library at your desk.

Involved with MIL SPEC or Hi-Rel components? Our Hi-Rel/Military Digest can lighten your load. Simplified cross-referencing and a user-friendly format eliminate time-wasting searches through QPL's, MIL-STD 1562,

DESC drawings and manufacturer catalogs. Searches that previously took hours can be done in minutes.

And to keep up with the latest technology, the DIGESTs feature optional Updates, automatically sent to you either quarterly or semi-annually.

We offer the DIGESTs separately, discount them in quantity, and, of course, all DIGESTs carry our 30-day moneyback guarantee. We also lease our database on magnetic tape.

To find out more about how the DIGESTs can simplify your workload, call our toll-free numbers.

The D.A.T.A. DIGESTs: getting out the work doesn't have to be a workout anymore.

the DIGESTs™
where semiconductor selection begins

Brochure surveys VLSI board-test systems

This 12-pg, 4-color brochure provides an overview of the five members of the vendor's L200 VLSI board-test systems. Discussing the features that provide cost-effective solutions to individual test requirements, the brochure elaborates on the modular architecture and the

use of the VAX/VMS platform. Further, the pamphlet describes the software support for all the systems: the L200 test-development environment and in-circuit pattern libraries, the Lasar Version 6 simulation system for functional test-program generation, and the Board-Watch networking and test-data management system.



Teradyne Inc., Inquiry Systems & Analysis, 25 Drydock Ave, Boston, MA 02110.

Circle No 458

IF YOU STILL THINK YOU NEED LONG LEAD TIMES AND HEAVY PREMIUMS FOR CUSTOMIZED LINE CONDITIONERS, THINK AGAIN!



DISPLEX DELIVERS IN A FRACTION OF THE TIME! AT A FRACTION OF THE COST!

What's our secret? Two things. One, CAE/CAD to speed up the design and specification process. Two, a complete line of pre-engineered, pretested off-the-shelf modules that can be assembled quickly in any configuration—with any combination of features and options.

Engineered to eliminate line noise, spikes and surges, they're easily tailored to your specific needs—without costly "customization" delays. Features include: Magnetic circuit breaker protection. Field replaceable surge suppressors. Full status indication. High inrush current and brownout protection. With noise-free zero current switching, they can operate with nonlinear loads and any power factor. Call or write for details: (516) 671-4400.

DISPLEX, INC. Subsidiary of North Hills Electronics
1 Alexander Place, Glen Cove, New York 11542 (516) 671-4400. TELEX: 46-6886

CIRCLE NO 232



Listing of connectors

The vendor's 12-pg catalog of BLC Breech-Lok connectors features specifications, mechanical drawings, contact arrangements, and information about backshell accessories, crimp contacts, and service tools. Also included is information about straight plugs; mounting, in-line, and jam-nut receptacles; and protective covers.

Carrot Components Corp., 750 W Ventura Blvd, Camarillo, CA 93010.

Circle No 459

Different. By design.

It begins with an idea.

A seedling is painstakingly cultivated to match the vision of the bonsai gardener. At Corning, glass tubing is precisely engineered to solve a specific design problem.

What do you need?

Need a glass for sealing to metal? Or a graded seal for glass-to-glass sealing?

Come to the solutions people.

Do you require OD tolerances that are "All-Points-In" at every cross section of the tubing? Corning's process controls guarantee A.P.I.

Looking for an ID tolerance $\pm 0.0005"$ for a laser application? We've got the glass tubing you need.

Whether you require a specific physical or chemical property or a *combination* of special characteristics, look no further. Corning is the *leading supplier* of electronic and industrial glass tubing for a broad and diverse range of applications:

- CRT neck tubing
- Ozonator tubing
- Power tube envelopes
- Electronic tubing and bulbs
- Cladding for fused and flexible fiber optics
- PYREX® tubing for solar collectors
- Diode encapsulation
- Cladding glass for micro-channel plate fibers
- VYCOR® tubing for heater jackets

World's largest selection.

Come to us for your design solutions. We can draw on the world's largest selection of glass compositions to produce tubing on a stock or make-to-order basis.



Find out how Corning can make the difference in your design. Contact the solutions people or circle the reader service number.

FREE Thermal Properties Chart

- ☐ Send me my FREE wall chart displaying the coefficients of thermal expansion and strain points of 47 of Corning's glass compositions.
- ☐ Send me more information on Corning's glass tubing.

Name

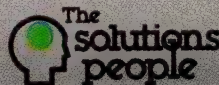
Title

Company

Address

City State Zip

Phone ()



Materials Business
Corning Glass Works
MP 21-3-4
Corning, NY 14831
607-974-4454

CORNING

SOFTWARE REVIEW

Filter-design package offers a variety of filter types

Filter Design and Analysis System. Momentum Data Systems, 1666 Newport Blvd., #115, Costa Mesa, CA 92627. Phone (714) 548-3257. Version 2.0, \$895; code generation, \$200.

Designing filters is easier when you don't have to calculate filter coefficients. It's even easier when you can try various filters and view plots of their characteristics. The Filter Design and Analysis System allows you to design, evaluate, and create code for a variety of digital filters. The system is well documented, easy to use, and very flexible.

The package runs on IBM PC, PC/XT, PC/AT, PS/2, and compatible computers. It supports most popular graphics interfaces, printers, and plotters. The graphs displayed on the CRT and the hardcopy devices provide a higher quality

than most filter-design packages—high enough for use in reports and manuals. You can use a graphics-interchange file that lets you incorporate the plots in various desktop publishing systems. The software is easy to install; the manual provides easy-to-follow instructions. Operating the system is also easy—its menu-driven operation guides you. Also, the system checks your input for errors while you're entering it.

The main menu lets you design an infinite-impulse-response (IIR), finite-impulse-response (FIR), or equiripple filter; analyze a digital system; or read a filter-specification file. After you've made selections from the menu, the program accepts the screen when you press function key F10.

For IIR filters, you can employ a bilinear-transformation or impulse-invariance design method to design a lowpass, highpass, bandpass, or

bandstop filter. You enter the characteristics of the filter by filling in blanks. The system then calculates the estimated order for four types of filters: Butterworth, Chebyshev, elliptic, and Bessel. You then select the filter type and order.

Next, the output-options screen is displayed. This screen allows you to select from a wide variety of plots on the screen and on the hardcopy. You can "zoom" by selecting start and stop ranges. The plot options include magnitude, log 10 magnitude, poles and zeros, impulse and response, group delay, phase, and step response.

In addition, the output-options screen allows you to quantize the filter coefficients over the 8- to 32-bit range. All of the internal calculations provide 64-bit, floating-point precision. The quantization option allows you to vary word sizes and determine the effects of the

Your own circuit designs are accepted!

CARDS FOR PC/AT

- * 386 Main Board (w/80387 function)
- * AT M/B 6/8/10/12MHz, w/RS232
- * Baby AT M/B 6/8/10/12MHz, w/RS232
- * SUNTAC Baby AT
- * NEAT Baby AT
- * E.G.A. Card (2/4 layers)
- * V.G.A. Card
- * HD/FD Controller Card

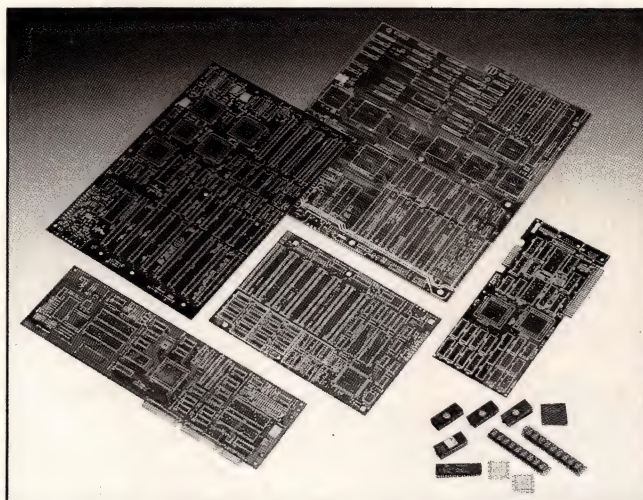
CARDS FOR PC/XT

- * 8MHz Turbo (2/4 layers)
- * 10MHz Turbo (2/4 layers)
- * Mini XT Turbo, 4.77/8/10MHz
- * Speed Card
- * MGP/CGP
- * Multi I/O Card

OUR PRODUCT LINE INCLUDES:

- * Double-Sided PCB's
- * Multilayer PCB's (4 to 8 layers)

A MARVEL OF PCB'S WORLD



Manufacturer & Exporter

GOOD FOLD ENTERPRISE CO., LTD.

Head Office:
2nd Fl., No. 392, Tun-Hwa S. Rd., Taipei, Taiwan, R.O.C.
Telex: 13323 GOODFOLD Fax: 886-2-7723407
Tel: (02) 752-6670 (6 lines)

WE CAN SUPPLY C.K.D.

W.T.F.

Top Gun in High-Rel SRAMs.

Also available in commercial versions.



Set your sights on our new 256K SRAMs.

These High-Rel SRAMs offer you all these benefits:

- 100 ns access time at 25°C
- Low standby current: 1 mA typical
- Full Mil temperature range
- 32Kx8 organization
- 28 Terminal DIL Package
- Screened to Mil-Std-883 Class B.* So they're perfect for use in a wide range of military systems. And, as you'd expect from the leaders in High-Rel CMOS, we have a full line of SRAMs, including 64K (8Kx8) and 16K (2Kx8).

Top in Rad-Hard RAMs, too.

If you need rad-hardness, remember that we offer 1K, 4K and 16K CMOS/SOS RAMs as well.

Our Rad Hard 16Kx1 CMOS/SOS RAM has an access time of 125 ns at 25°C and is available for immediate delivery to Class S type specifications.

CMOS/SOS is the ideal technology for rad-hard applications because:

- It's latch-up free under transient radiation
- It's highly tolerant to single-event upset caused by radiation (typically 2×10^{-9} errors/bit/day)
- It has total dose tolerance from 100K RADs to "MEGARAD."

We know, because we invented CMOS/SOS.

So whatever your needs in SRAMs, aim high, and call the Top Guns today. For additional information, call toll-free 800-443-7364, extension 20. Or contact your local GE Solid State sales office or distributor.

*Rev. C, Paragraph 1.2.2



GE Solid State

GE/RCA/Intersil Semiconductors

Three great brands. One leading-edge company.

In Europe, call: Brussels, (02) 246-21-11; Paris, (1) 39-46-57-99; London, (276) 68-59-11; Milano, (2) 82-291; Munich, (089) 63813-0; Stockholm (08) 793-9500.

NAVY SLASH SHEET POWER SUPPLIES



NAVY STANDARD POWER SUPPLIES ARE HERE . . .

- Qualified By The U.S. Navy
- 100,000 Hour MTBF
- Reduced Acquisition And Life Cycle Costs
- Improved Maintainability
- Standard Navy Physical And Electrical Interfaces
- MOSFETS switched at high frequency

Navy Standard Power Supplies are now being mandated in Navy contracts. All Navy Standard Power Supplies meet general NAVSEA specification SE 010-AA-SPN-010, and appended slash sheets identify individual model characteristics.

EG&G Almond Instruments' *slash sheet* power supplies are being qualified by the Naval Weapons Support Center (NWSC), Crane, Indiana as part of the Navy Standard Power Supply program (SPSP).

For more information on the Navy SPSP and our 150 watt, 300 watt, and 750 watt SPSP Slash Sheet units, contact Dave Adams, Director of Marketing.

CIRCLE NO 266



EG&G

ALMOND INSTRUMENTS

1330 E. CYPRESS ST., COVINA, CA 91724 • (818) 967-9521 • TWX 910-584-1320

SOFTWARE REVIEW

resolution. Other options allow you to create files for code generation, for future use, and for graphics interchange.

The FIR-filter design option works in a similar way. It supports lowpass, highpass, bandpass, bandstop, and differentiator filters with rectangular, triangle, Hanning, Hamming, Blackman, and Kaiser window functions. Once you've entered the filter characteristics, the system gives an estimated number of taps for each filter type. As in the IIR option, an output-options screen controls the output; however, it supports only magnitude, log-10-magnitude, impulse-response, and step-response plots.

The equiripple FIR-filter design is based on the Parks-McClellan algorithm; it helps you design lowpass, highpass, bandpass, bandstop, differentiator, multiband, Hilbert-transform, and arbitrary-magnitude filters. The use of this section is similar to that of the FIR option, except that in the equiripple option, you have to enter each band. The characteristics you use should be realistic: If your band transition is too steep, the system will not produce a result.

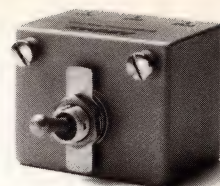
The analysis system also lets you analyze digital systems. You enter the transfer function in either the s or the z domain. You can then use an output-option screen similar to the one the IIR filter provides.

Two code generators take the filter you designed and convert it to source code. One generator creates code for the Motorola DSP56000, and the other produces code for the Texas Instruments TMS32010, TMS32020, and TMS320C25.

—David Shear

AIRPAX MIL-C-39019 BREAKERS OFFER A SPECIAL ATTRACTION.

Magnetic circuit breakers offer the best performance under the most extreme conditions. That's something to consider when your application involves the inside of a tank, warship or tactical aircraft. When things start getting hot, thermal breakers start breaking down. That's why more mili-



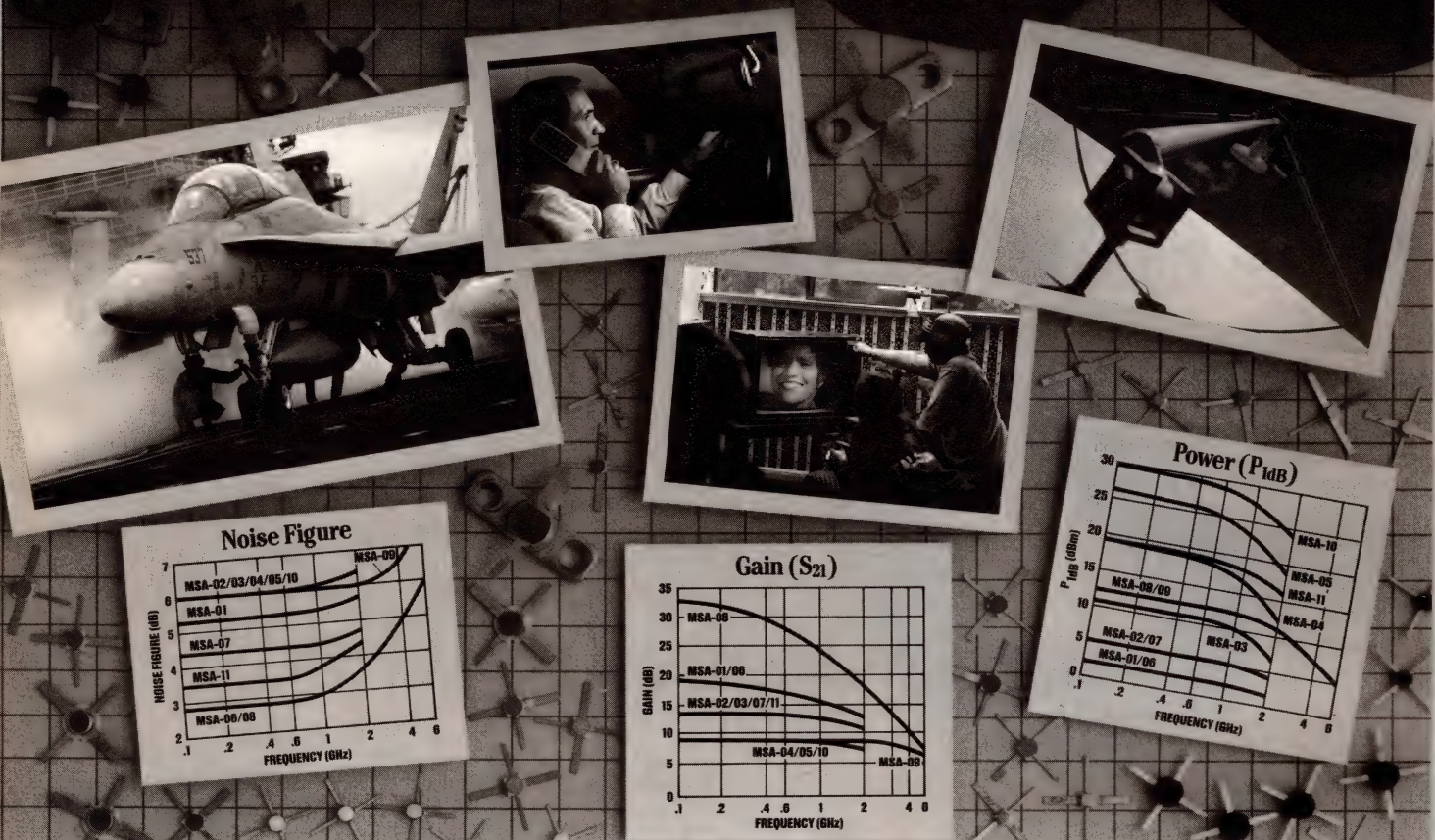
tary design engineers are depending on the Airpax Type AP electromagnetic circuit breaker. For performance backed by Airpax quality. The same quality which has enabled us to meet—and exceed—specification MIL-C-39019 for the past twenty years, without fail. No other manufacturer can offer you that assurance.

High-reliability applications deserve a high-reliability circuit breaker. And you won't find one any more reliable than the Airpax AP magnetic circuit breaker. The proof's in the record. Twenty years of market leadership. Twenty years of MIL-C-39019 approval. Call or write Airpax Corporation, Cambridge Division, Woods Road, Box 520, Cambridge, MD 21613. (301) 228-4600. A North American Philips Company.



AIRPAX®
CAMBRIDGE DIVISION

Silicon MMICs Any Way You Want!



Avantek Offers the Widest Selection of Wideband Silicon MMIC Amplifiers

Now the trade off between performance, package and price is easier. Avantek has a package/die combination that offers the ideal solution to your overall system performance and cost goals. Our MODAMP™ series, DC to 6 GHz silicon MMIC wideband amplifiers, includes eleven different amplifier die types and nine package options. A total of more than 70 different models. These MMIC amplifiers are available with a wide spectrum of performance options to satisfy nearly every design need.... Minimum noise figures as low as 2.8 dB, gains as high as 33 dB, and P_{1dB} as high as 29 dBm.

Packages — Low Cost to High Rel

The MMIC performance you need is available in a range of packages to fit your overall

system design and cost needs. Avantek's new Package "86" (85 mil surface mount plastic package) combines premium performance with low cost. Both Package "86" and the industry standard SOT-143, are available on tape and reel, making them ideal for low cost, high volume applications. For high reliability applications, such as space or military environments, we offer MODAMP MMICs in a range of hermetic metal/ceramic packages. MODAMP packages include:

- SOT-143 Plastic
- 4-Pac Plastic
- 85-Mil Plastic
- 85-Mil Plastic Surface Mount
- micro-X Stripline
- 70 Mil Hermetic
- 100 Mil Hermetic
- 200 Mil BeO
- 230 Mil Flange

Available in Quantity for Volume Applications

Avantek presently produces more than 1,000,000 MMICs per month. So you can be assured the MMICs you need will be available to support your volume production programs. And, all MODAMP MMICs are in stock at your local Avantek distributor. For additional information, or the name and address of your local distributor, contact the regional sales office nearest you.

Regional Sales Offices

North America

Eastern: (301) 381-2600

Central: (214) 437-5694

Western: (805) 373-3870

European: (44) 276-685753



3175 Bowers Avenue
Santa Clara, California 95054-3292

BOOK REVIEW

A "civilized" look at the engineering profession

The Civilized Engineer, by Samuel Florman. 258 pgs; \$15.95. St Martin's Press, 175 Fifth Ave, New York, NY 10010.

Richard Simonelli,
Engineering Consultant

Are you a civilized engineer? Do you know something about the history of our profession? Do you know what motivates us as professionals? Have you thought about the profession's strengths and weaknesses?

Samuel Florman raises these prickly questions and many more in his controversial book, *The Civilized Engineer*. If you missed the book when it was first published in 1987, then read it now. Florman, a practicing civil engineer, provocatively discusses engineering's place in modern society and our values. He covers the ethics, the responsibili-

ties, and the risk-taking issues posed by the Challenger disaster.

The author's arguments are direct—neither pedantic nor abstract. His tone expresses a deep pride in the profession, but at the same time, acknowledges that something is amiss.

Metaphorically, Florman argues, engineers are "uncivilized." To Florman, civilization refers to a broadening of horizons and a deepening of cultural awareness. Are we too narrowly educated and focused on our work to be effective as well-rounded citizens in the complex future?

The author traces the roots of engineering back to toolmaking. He follows the trail through ancient Greece and Rome, on to the Middle Ages and the Renaissance. Finally, he places modern engineering's origins in the tradition of Western craftsmanship.

During the industrial revolution

of the 17th and 18th centuries, the British took a hands-on approach to engineering, while the French and continental approach emphasized polytechnic education and cooperation among government, industry, and academia. However, both approaches are alive today in North American engineering.

Florman points out that the term "ethics", as it applies to engineering, means something quite different from its meaning in other contexts. He writes: "A conscientious engineer, by definition, can not falsify test reports or intentionally overlook questionable data, cannot in any way evade the facts." As engineers, our ethics and viewpoints result from the black-and-white nature of our products: Things must work.

Florman always renders criticism with respect. His purpose is not to shock or denigrate the engineering

PP Modular Computers®

Pep... a step ahead!

Please visit us
at
MIDCON
Booth No. 446/448

VIOXROM... a universal SW interface for VME intelligent I/O modules

VIOXROM is based upon a real-time kernel and distributes I/O functions over one or more intelligent I/O boards using data- and device-independent mailboxes instead of physical ports. You need not program the on-board kernel, the SW is ready-to-go!

The VIOXROM concept:

- standardizes system I/O functions
- enables OS-independent I/O functions
- provides a standard development environment

Your benefits include:

- reduces SW-development time
- is HW independent
- offloads VMEbus and master CPU
- compatible with VMEPROM
- requires no extra SW license

USA + Canada	Germany	Sweden	France	Japan
Pittsburgh	Kaufbeuren	Taaby	Paris	Osaka
412-279-6661	(8341) 8 10 01	(8) 7 56 72 60	(1) 45 34 60 60	(6) 8 76 06 15



CIRCLE NO 237

BOOK REVIEW

profession, but to ask the unaskable. But some of his conclusions are grim:

- As engineers, our interests are narrow, and our specialties are all-consuming; we can't afford to be curious about areas outside our work.
- We are often insensitive and indifferent to human rela-

tions, finding them to be too much of a gray area.

- Compared with other professions, we are poorly educated in the humanities, and we are contemptuous of such learning.

As a result of these shortcomings, Florman contends, we fail to comprehend the cultural and social im-

plications of our work, preferring to look the other way. As psychological types, he adds, we are often wooden, rigid in areas outside of technology. Florman maintains that we're easily manipulated as a group, and that we contribute less than our share to community and national leadership. It is courageous and timely of Florman to air this subject.

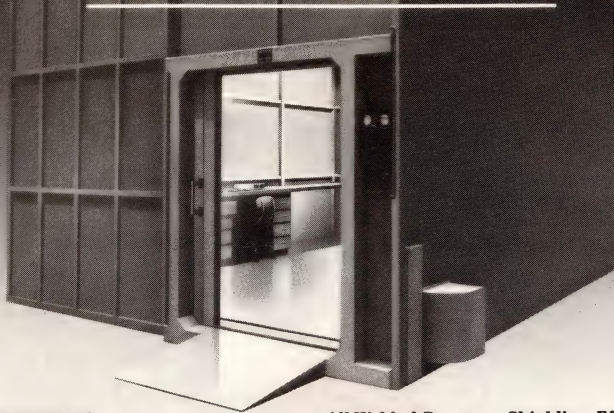
Florman encourages us to improve the humanities education available to those engineering students desiring it. Current accreditation standards require engineering students to take 12.5% of their courses in liberal-arts areas, yet, Florman says, most students show disdain for such studies. "Most of the young engineering students I meet these days want to take technical courses that will maximize their chances in the job market," he laments. "They don't want to spend a day or a dollar more than necessary in pursuing their degrees, and they are not at all convinced that the humanities are relevant to their concerns."

Florman believes that a better grounding in the humanities and social sciences would prepare more students for an engineering career involving leadership and communication skills. The idea of encouraging some students, and not others, to prepare for a leadership role naturally leads to cries of elitism. However, he argues that each person should have the opportunity to rise to the full extent of his or her abilities.

An engineer will come away from this book with both a sense of pride and a challenge not to rest on his or her laurels. It places the profession in perspective and makes concrete proposals for changes that will benefit the individual engineer, the profession, and our society. **EDN**

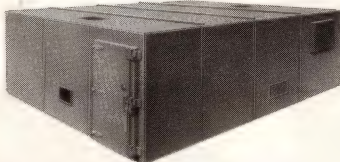
Richard Simonelli is an engineering consultant in Boulder, CO.

Shielded rooms with a roomful of benefits.



LECTROSHIELD® Clamp-Together Rooms — Shielding Effectiveness to 100 dB+.

- 1.0 KHz to 10 GHz attenuation for MIL-STD-285, NSA 65-6, FCC and VDE testing, MIL-STD-461/2/3, etc.



- Prefabricated, modular.
- 48 standard room sizes... 8' x 8' to 24' x 48' (interior), standard interior heights to 8', 10' and 12', plus custom sizes.
- Easily assembled and dismantled.
- High reliability electrical and structural.
- Meets stringent building and safety codes, including Seismic Code Zone IV.

All-Welded Rooms — Shielding Effectiveness to 120 dB- 140 dB+.

- Meets TEMPEST and other secure requirements.
 - Ideal for EMP hardening.
 - Free standing; total structural and seam integrity.
 - Patented sliding doors exceed MIL-STD-285 and NSA 65-5.
 - MIG welding throughout.
 - TEMPEST shielded security vaults.
 - Standard and customized sizes.
 - Maximum fire protection.
 - Complete design and turn-key facilities.
- Plus... shielded anechoic chambers, chambers for Nuclear Magnetic Resonance (NMR) imaging systems, and a complete line of RFI/EMI filters and filter panels.

LMI has the shielding solution for you. Write or call the LMI Application Engineering Department.



Nationwide representatives

LECTROMAGNETICS, INC., 6056 West Jefferson Blvd., Los Angeles, CA 90016
(213) 870-9383, Toll Free (800) 325-9814-U.S.A. • (800) 325-9815-CA

CIRCLE NO 238

This tiny vibration is about to give your customer the shakes.

Put a damper on vibration with 3M Scotchdamp™ Vibration Control Systems.

It's a fact of science. As materials become lighter, they are increasingly prone to the disruptive effects of vibration. Now there's a solution that makes life a lot easier for today's design engineers—Scotchdamp Vibration Control Systems.

Custom designed to your exact specifications, these systems combine energy dissipating polymers with other key materials to solve specific vibration problems. For example, stainless steel dampers, now being used on hard disk drive suspension assemblies, virtually eliminate vibration and thereby reduce data errors.

If you're designing electro-mechanical devices of any kind, Scotchdamp Vibration Control Systems

can help you eliminate troublesome vibrations. Team up with 3M, a world leader in vibration control materials, to increase your customers' satisfaction—and yours—through vibration-free product performance. Circle the reader service number or write: 3M Industrial Specialties Division, Building 220-7W-04, 3M Center, St. Paul, MN 55144-1000. Better yet, call (612) 733-7411 today.



3M

CIRCLE 4 FOR INFORMATION

CIRCLE 3 FOR SALES ASSISTANCE

Fast

When it comes to MIL-STD-1553, Micro-Rel is fast on its feet. We know that on-time product delivery is a promise rarely met. So we *guarantee* delivery to meet your schedule. How does Micro-Rel do it? We're vertically integrated, so each step of the "1553" component cycle is reduced. From design, to manufacturing, to final product—it all takes place under one roof—our own.



Power dissipation can be a problem in MIL-STD 1553 performance. Not with Micro-Rel's line. Our advanced technology allows us to make "1553" products that use less power. So you'll need less beefy power supplies and less elaborate heat sinking. The bottom line? Micro-Rel products operate cooler and live longer.

Cool

Tough

Micro-Rel's "1553" testing procedures make field conditions a snap. We can handle the toughest product specifications because we learned our lessons in the most critical application known to man...the human body. As one of the world's largest manufacturers of medical electronics, we're used to exceeding ridged standards, not just meeting them.

If you're tired of waiting and waiting for your "1553" components...tired of bad thermal management...and you're ready for superior performance, contact Micro-Rel. We're fast, cool and tough.



MIL-STD-1553



Micro-Rel

2343 West 10th Place
Tempe, AZ 85281
TEL: 602-968-6411
TWX: 910-950-1941
FAX: 602-968-9691

Design firms: A little bit of engineering heaven

Deborah Asbrand, *Associate Editor*

Independent design firms differ from traditional manufacturing companies in many ways. For one thing, they don't require engineers to perform product-support tasks or to prepare voluminous amounts of paperwork. They're strictly no-frills environments—no thickly carpeted, color-coordinated offices. Instead, the emphasis is on engineering. When clients are footing the bill, designs that are “good enough” aren't good enough. A client-driven, deadline-oriented environment isn't for everyone, but for engineers who enjoy that atmosphere, it can be a little bit of engineering heaven.

Engineer Bernard Daines founded Tidewater Associates, a Union City, CA, design house, in 1984. After having worked for two years as an independent consultant, Daines was anxious to take on meatier assignments. “I had a hunger to do bigger projects than I could on my own,” he says. In 1981, he invited his younger brother, Nolan, to join his consulting practice, and three years later, they incorporated to form Tidewater.

The concept of a “full-service development firm,” as Bernard Daines likes to call it, is new. Independent consultants and job shoppers are fixtures in the electronics industry. But the idea of a service company that maintains its own facilities and equipment and uses them to develop products for other companies is a new twist. Many people, Daines admits, aren't sure quite what to make of this recent addition to the electronics sector. To help remedy the situation,

Daines recently hired a public-relations firm to promote not only Tidewater's services but also simply the idea of a full-service development firm.

Consulting companies such as Tidewater are sometimes referred to as “hired guns.” Daines doesn't appreciate the

“All we have to offer is hard work and interesting projects.”



Tim Davis

Bernard Daines, Founder, Tidewater Associates

"Clients' engineers need to support and manufacture a product. They want to maintain a close link with the designers."

comparison. The company emphasizes that its working style is cooperative. "Clients' engineers need to support and manufacture a product," sales and marketing director Mike Gifford asserts. "They want to maintain a close link with the designers."

Tidewater's perseverance as a full-service development firm has paid off—its business is booming. In the company's early days, a \$150,000 contract was a large one. Now, says general manager

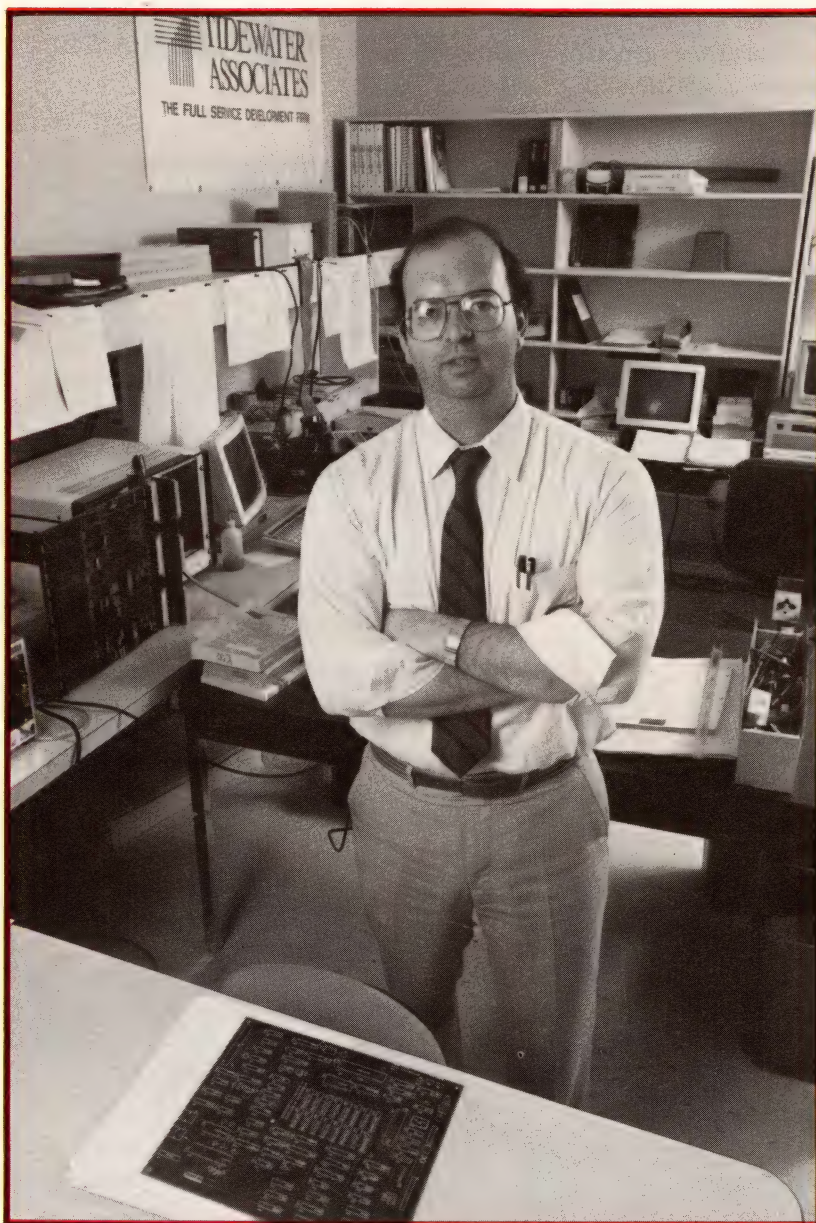
Larry Heaton, that's about the smallest contract the company will accept. This year, the company expects to pull in \$8 million in revenue.

Tidewater's Union City location typifies its no-nonsense attitude. Union City is short on local color; it got its inauspicious start 20 years ago when area townships filled in the marshy, southernmost tip of San Francisco Bay. Today, it's a city made up largely of industrial parks. Work is the order of the day.

The firm currently occupies 15,000 square feet of space, which it has leased since 1981, when the Daines brothers moved their operation out of their garage. The space, once mostly vacant, is now nearly filled, as a result of the company's growth. The company's quarters feature few of the usual corporate props. Instead of finding the typical roomy lobby with floor plants, couches, and an oversized version of the company logo behind a receptionist's desk, visitors to Tidewater squeeze into a small, plain waiting area. In contrast, generous amounts of space have been set aside for design, assembly, and manufacturing. Four cavernous bays, allow ample room for work on clients' products.

Notably absent from the structure are the ubiquitous modular cubicles that pass for office space in most companies. Tidewater maintains genuine offices for its engineers and technicians alike. Individual work spaces are walled off, and incandescent lighting softens the interior atmosphere. Also noticeably missing, however, are doors to each office. Bernard Daines chose to keep the offices doorless as "a compromise between openness and privacy."

Clients retain Tidewater, and other design houses like it, for a number of reasons. Some engineering departments, for example, have come up with new ideas, but are too busy with existing projects to undertake the new ones. In other companies, the development of a



Tim Davis

Mike Gifford, Sales and Marketing Director

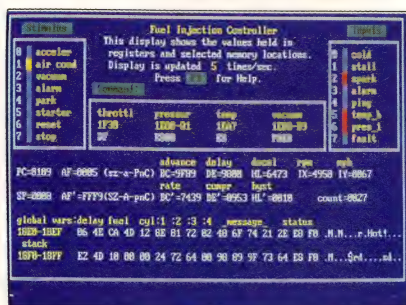
0 to 60 in 5 seconds



with new UniLab Microprocessor Development Tools

- 64Kbytes from hard disk to emulation memory in 5 seconds. That's moving. But today you've got to be fast just to stay in the race for better microprocessor designs.
- The secret is a new, high-speed parallel interface: the Orion bus. Which zips data between your PC/AT and the 8620 analyzer-emulator, breaking the RS-232 bottleneck.
- The 8620 with O-bus gives you complete program diagnosis — and solutions — in real time. For more than 150 different microprocessors. Using the same command set environment.

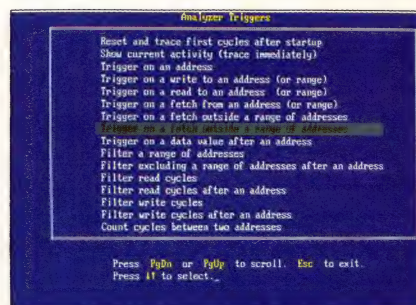
- A generous 2730 trace-cycle buffer with selective filtering lets you cut through the clutter and display just the traces you wish. And you get 1μsec resolution in program time measurement. Plus continuous InSight monitoring of your program's key functions as they are performed.



InSight Display. InSight blends analyzer-emulator techniques to give you continuous, real time monitoring of key processor functions. And still services user interrupts. It displays changing register contents, I/O lines, ports, user-defined memory windows. With your own labels.

- On top of that, you get UniLab's trademark ability to debug by symptom, not just by breakpoint and single step. And, to help you complete the job on time, on the spot, a stimulus generator and EPROM programmer are included.

- Ease of use, another Orion trademark, is also built in. So you have all the familiar features and formats you're used to working with. It doesn't matter if your project is a single chip controller or complex 16-bit



Analyzer Triggers. Commonly used triggers can be selected quickly from a list of standard and user-defined triggers.

microprocessor, the 8620 is the top price/performance analyzer-emulator that does it all. At just \$4380. With processor Personality Paks typically \$550 each.

- UniLab 8620. Fast-lane debugging that gets you to market quicker.

Call toll-free: 800/245-8500.
In CA: 415/361-8883

ORION
INSTRUMENTS

702 Marshall St., Redwood City, CA 94063
TLX 530942 FAX 415/361-8970

Computer Integrated Instrumentation

new product requires engineering expertise in an esoteric area, and rather than recruit and hire an engineer with the necessary knowledge, the company turns to a service company. Start-up companies that as yet lack their own engineering departments are also customers.

For some companies, the decision to approach a design firm for assistance can be gut-wrenching, particularly for firms that have gone to great expense to hire talented engineers only to load them with so much work that they're unable to proceed with the development of a new-product idea. "We may talk to a vice president of engineering who feels guilty about coming because he's got a staff full of engineers," says Gifford. "He also may be wrestling with the not-invented-here syndrome."

For the engineers who work at Tidewater, the client-driven atmosphere can be a pressure cooker. At any given time, Tidewater's engineers are working on 20-odd projects of varying sizes. The company bills its clients for its engineering services, and each engineer must keep meticulous track of the time spent on various projects. With clients footing the bill, deadlines take on new meaning. Says general manager Heaton: "At most companies, you have a deadline you don't make and you go in and ask for another six weeks. Here you can't do that."

Like employees of any service-oriented business, Tidewater's engineering staff must acquire a certain amount of finesse in working with their clients. "We once ran into a 3-week delay while a client decided on the color of a keyboard," sighs Heaton.

With each engineer juggling several projects at once and facing constant deadline pressures, there's little time for conversations at the water cooler. Tidewater's growing business keeps the engineers' between-project time to a minimum. Paul O'Connor, who joined Tidewater in 1987, says that his previous jobs with defense contractors always

included a cooling-off period between contracts. It's not so at Tidewater, he says; there's always a new project to be tackled.

That kind of intensity isn't for everyone. Tidewater has lost several talented engineers who simply felt that the required level of involvement was too much for them. Mukesh Patel had similar thoughts when he joined the company in 1985. Battle weary from years of negotiating Silicon Valley's congested freeways, Patel's criterion for a new job had been reduced to one simple requirement: He wanted a commute of no longer than 15 minutes. Tidewater, located just a short distance from his home, fit the bill. Though he loved the short commute, he had originally planned to stay just one year. "I thought this place would be a sweatshop," he concedes. Since joining the company, he's worked on a project in video imaging, one in voice synthesis, and Project Victoria, an ISDN project. Now, he enthuses, there are few engineers in Silicon Valley who can match his resume. Agrees Nolan Daines: "We get to do the stuff that really raises the hair on the back of your neck."

The charged atmosphere results from Bernard Daines' business savvy rather than any desire to create an engineering utopia. "It wasn't structured to be a mecca for engineers, because all we have to offer is hard work and interesting projects," explains Daines, who is himself a veteran of Hewlett-Packard and IBM. "The thing that makes working here interesting is that the engineers don't have to live with a project for three years. I'm not knocking that, but I think there are a lot of really creative people who are banging out logic designs and feeling very frustrated."

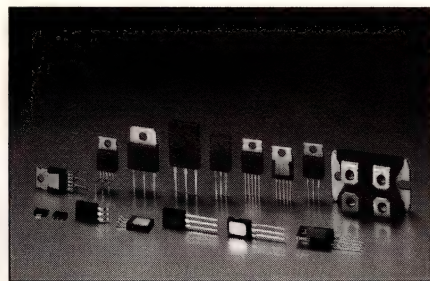
Indeed, a single recruitment ad for Tidewater typically produces 50 resumes. Tidewater is selective, and not everyone makes the grade. Heaton estimates that 20 to 25 of the inquiries are from qualified applicants, and of those,

A client-driven, deadline-oriented environment isn't for everyone, but for engineers who enjoy that atmosphere, it can be a bit of engineering heaven.

High Performance N-Channel PowerMOS Transistors

A new family of nearly 200 n-channel PowerMOS transistors from Philips Components offers the highest performance available, yet costs no more than existing devices. The BUK family of transistors spans low, medium and high voltages (up to 1000 V), and includes devices for use in such applications as automobiles and inverters.

The low-voltage transistors have cell densities of 1.6 million cells per square inch, which results in drain-source on-resistances as low as 25 m Ω . This feature is a key measure for PowerMOS devices, and corresponds to drain currents up to 56 A. Philips' new BUK family includes 14 low-voltage logic-level devices for 12 V battery operation in automotive and industrial applications, and 13 high-voltage FREDFETs for bridge or half-bridge applications in motor control, uninterruptible power supplies and inverters.



There are 74 low-voltage transistors with crystal sizes between 6 mm² and 20 mm², and with maximum drain-source voltages between 50 V and 200 V. Even the lowest voltage transistors in the family, such as the 50 V BUK453-50A, can carry up to 22 A drain currents because of $R_{DS(ON)}$ values as low as 80 m Ω .

There are 72 medium-voltage devices with drain-source voltages between 400 V and 600 V. These devices include 400 V transistors with $R_{DS(ON)}$ values of 400 m Ω and maximum drain-source currents of 14 A, and 600 V devices with $R_{DS(ON)}$ values of 800 m Ω , passing currents of 10 A.

Thirty-eight high-voltage transistors withstand between 800 V and 1000 V. These include 800 V devices with $R_{DS(ON)}$ values down to 1.5 Ω and corresponding drain-source currents above 8 A, and 1000 V transistors with $R_{DS(ON)}$ values of 2 Ω , passing currents of nearly 7 A.

Switching times are in the low tens of nanoseconds, allowing the transistors to operate at frequencies up to 10 MHz in resonant power supplies, for example. The devices are available in a choice of

five packages, from the SOT-186 – a fully isolated version of the TO-220, which dissipates up to 30 W – to the SOT-93 (TO-218), which dissipates up to 250 W. Devices in other packages are in development.

CIRCLE NO 259

Range of SensorFETs Provides "Loss-less" Load Protection

By dedicating a few of its cells to current sensing, this range of SensorFETs from Philips Components provides "loss-less" overcurrent, or short-circuit, protection for a wide variety of automotive and industrial applications. Unlike most power MOSFETs, which detect load currents using a high-power resistor, these new SensorFETs use some of their current-carrying cells to direct a proportion of their current – a few milliamps – to an external control-regulation circuit.

The four SensorFETs that make up the BUK700 series can be used whenever current limiting is needed to protect equipment – such as motor drives – from damage. The BUK793 and BUK795 have maximum drain-source voltages of 50 V or 100 V.

These SensorFETs have densities of 1.6 million cells per square inch, the highest in the industry for these types of devices. This density cuts the drain-source on-resistance to between only 40 m Ω and 800 m Ω , depending on the device, and leads to current-handling capacities of up to 40 A for the 50 V devices and up to 25 A for the 100 V devices.

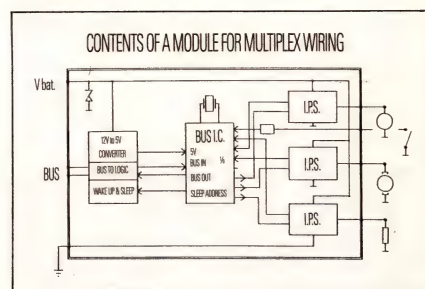
The SensorFETs come in TO-220 Pentawatt packages. Samples are available.

CIRCLE NO 260

11 A High-side Switch for Automotive Applications

A new MOS Intelligent Power Switch has a drain-source, on-resistance $R_{DS(ON)}$ of only 33 Ω , four to eight times lower than that of other such devices. Called the BUK196-50, the new device from Philips Components passes a drain-source current of only 11 A and its $R_{DS(ON)}$ matches the low contact resistance of mechanical relays, making it a suitable replacement for such relays in a variety of automotive and industrial applications.

The BUK196-50 is an n-channel transistor that fits on the battery-side (high-side) of the load. It incorporates short-circuit and thermal protection, and features current-sensing circuits. An integ-



ral charge pump boosts the car-battery voltage to ensure that the MOSFET saturates fully, even when the battery voltage falls to 6 V. A status indicator signals that the device is functioning, thus closing the feedback loop between the drive and switch.

The device connects directly to the industry standard decoders for the multiplexed bus systems that will appear in the next generation of automobiles.

The low on-resistance comes from the high cell density – 1.2 million cells per square inch – of the BUK196-50. The high cell density also leads to the device's 11 A rated current, which is maintained even with a case temperature of 85 °C and battery voltage as low as 6 V. The low on-resistance also leads to low losses – the device has a low quiescent current of less than 10 μ A. The transistor also has a maximum drain-source voltage rating of 50 V. Its projected MTBF is as good as the standard Philips MOSFET.

The BUK196-50 comes in a TO-220 Pentawatt package. Samples will be available in November.

CIRCLE NO 261

PHILIPS: YOUR POWER SOURCE

FOR A FREE FLOPPY detailing the Philips PowerMOS range, circle **262** on the Reader Service Card.

For information on Philips power products, please contact:

Europe: Philips Components, Hazel Grove, United Kingdom. Tel. (061) 483 0011.

Far East: Philips Components, Metro Manila, Philippines. Tel. (632)801-11-817089.

North America: Amperex, Smithfield, Rhode Island. Tel. (401)232-0500.

Philips Components

With clients footing the bill, deadlines take on new meaning. Says general manager Heaton: "At most companies, you have a deadline you don't make and you go in and ask for another six weeks. Here you can't do that."

no more than six make the second cut and are interviewed. "We get people who come in and say they've been doing 68000 work for 15 years," says Heaton. "But their involvement has been taking a small segment and passing it on. Those people don't have the global understanding of the product that we need here."

John McGinnis is an industry veteran and specialist in image recognition. He's now director of engineering for Tidewater. He characterizes the company's environment as "very, very different" from the other companies he's worked for. In the engineers he hires he looks for "a willingness to take chances—not someone who wants to analyze something forever."

Despite the breadth of his managerial responsibilities, Bernard Daines manages to remain an active team member

on about four projects at a time. He enjoys the thrill of the new-product chase, he says, and he looks for that same enthusiasm in the engineers he hires. "I'm excited about every new project that we start. If the same enthusiasm to build things and make things work isn't there, then the person isn't suited to this thing."

EDN

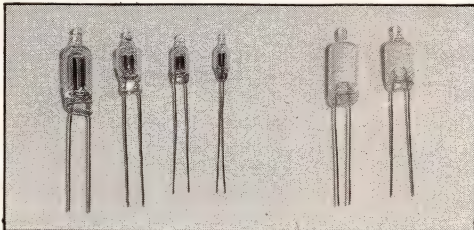
Article Interest Quotient (Circle One)
High 491 Medium 492 Low 493

we have bright ideas for specialized industrial lamps.

NEON LAMPS

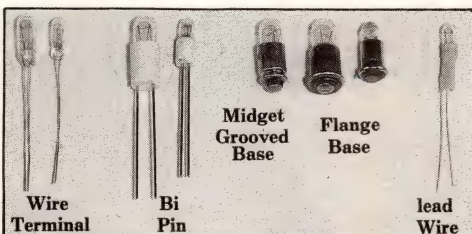
DIA.: 6mm, 5mm, 4mm, 3mm

TYPE: 1. Standard-Brightness 2. High-Brightness
3. Ultra-High-Brightness 4. Green (6mm, 4mm)



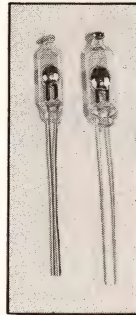
SUB-MINIATURE & MINIATURE LAMPS

DIA.: T3/4, T1, T1 1/4, T1 3/4 (2.3mm, 3mm, 4mm, 5mm)



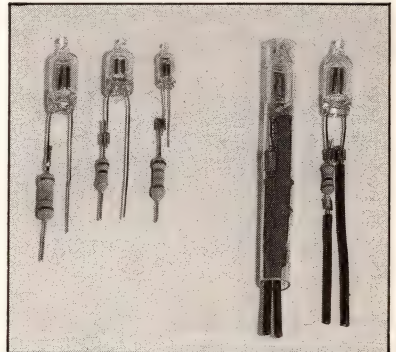
MERCURY SWITCHES

DIA: 5m. 6m.

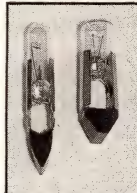


NEON LAMP ASSEMBLIES

1. Neon Lamps with Resistors and wires.
2. Customer's types are available.



TELEPHONE SLIDE LAMPS



MANUFACTURER & EXPORTER

TACHAI INDUSTRIAL CO., LTD.

TAIPEI OFFICE:

FL. 5, NO.486, MIN CHUNG E. RD.

TAIPEI, TAIWAN, R.O.C.

TEL: (02)5019747-8

TELEX: 22965 TACHAICO

FAX: 886-2-5057582



Here's what we're up to.

Ontario, Canada, is a place of achievement. We pioneered telecommunications. Hydro electric power. Satellite transmission. Space robotics.

The result—a well-established infrastructure of skilled suppliers to the North American electronics industry. If you haven't explored this alternative source for quality components, it's time you took a look at what's here.

We give you quality, at a competitive price, without the inevitable problems caused by distance and language differences. We're your neighbours, and we think and talk like neighbours.

When you source in Ontario, it's as easy as dealing with a domestic supplier. You may find us easier to deal with. Ontario is close to major manufacturing centres of the U.S., and our excellent transportation links make us a prime partner for JIT

and similar time-sensitive supply arrangements.

One phone call will bring you information about Ontario suppliers of the quality components you need.

Contact the International Electronics Marketing Consultant for the Government of Ontario, Canada at this number (416) 965-5436. Or write to the Ministry of Industry, Trade and Technology at 900 Bay Street, Hearst Block, Toronto, Ontario, Canada M7A 2E1. Fax: (416) 965-7791.

CIRCLE NO 243

Ontario, Canada: the best-kept secret of the North American electronics industry.



SEE US AT THE
MIDCON SHOW
BOOTHS
907-914

**ONTARIO'S
BUSINESS**

More than Competitive!

Ministry of Industry,
Trade and Technology



Ontario, Canada

HI-TECH CAREERS

As one of the top ten engineering leaders in the U.S., we want talented professionals with a mutual interest in technological development. Discover what we have accomplished in our 60 years of experience, and join our developments in advanced technology for the future.

TEAS GROUP—Located at Eglin Air Force Base, Florida Svt/TEAS provides Technical and Engineering Acquisition Support (TEAS) of conventional weapon systems development for the Air Force Systems Command/Armament Division. Enjoying the best of both high-technology challenges and a beautiful location among the white beaches of Florida's Emerald Coast, Svt/TEAS offers exciting opportunities in the following areas:

- **Systems Engineer (T-50).** To work on development of advanced electronic warfare threat simulation programs. Requires MS or PhD EE with 4-10 years experience in electronic systems integration and radar signal processing.
- **Systems Engineer (T-50).** To develop simulation of advanced missile systems. The successful candidate will also provide technical guidance on results of missile flights. Requires MS or PhD EE and 4-16 years experience in radar signal processing or missile simulations.
- **Software Engineer (T-50).** Responsible for software/embedded software applications in support of GPS integration with range systems. Position requires MSCS and 4-10 years related experience in software/embedded software.
- **Director, Guidance and Control Dept (T-60).** We seek an experienced engineering manager to direct the technical operations of several tasks involving guidance and control evaluation of tactical missile systems. This top

management position requires PhD in EE, AE, ME, physics or related discipline with 11-35 years experience and major strength in guidance and control.

- **Systems Engineer (T-60).** To perform 6-DOF analysis of missile performance. Position requires MS or PhD EE, AE, or physics and 1-10 years related experience with strengths in guidance and control and IR seekers.
- **Chief, Electronic Warfare (T-10).** The successful candidate will serve as technical chief for all threat simulator/electronic warfare tasks within the range systems SPO. Requirements include PhD EE, AE, physics, or math and 11-16 years related experience. Strengths must lie in ground-based threat simulators, radar systems, EW systems, and range systems.
- **Seeker Engineer (T-70).** To assist in Radome design and analysis for IR and MMW seeker. Requires MS or PhD EE or physics and experience in Radome design, IR, RF, and MMW.

Qualified applicants are invited to send a complete resume with salary requirements in strict confidence to:

Gregg Quinn
Manager, Professional Placement
SVERDRUP TECHNOLOGY INC.
 P.O. Box 884, Dept. T-12 • Tullahoma, TN 37388
 An Equal Opportunity Employer M/F/H/V

CAREER OPPORTUNITIES

1988 Editorial Calendar and Planning Guide

EDN
 Editorial Emphasis

Issue Date	Recruitment Deadline	Editorial Emphasis	EDN News
Sept. 15	Aug. 25	Data Acquisition, Data Communications, Digital ICs	Closing: Sept. 1 Mailing: Sept. 22
Sept. 29	Sept. 8	DSP, Graphics, Optoelectronics	
Oct. 13	Sept 22	Test & Measurement Special Issue, Instruments, Computers & Peripherals	Closing: Sept. 29 Mailing: Oct. 20
Oct. 27	Oct. 6	CAE, Computers & Peripherals, Integrated Circuits, Wescon '88 Show Preview	
Nov. 10	Oct. 20	Programmable Logic Devices, Integrated Circuits, Test & Measurements, Wescon '88 Show Issue	Closing: Oct. 27 Mailing: Nov. 17
Nov. 24	Nov. 3	Microprocessor Technology Directory Graphics, CAE	
Dec. 8	Nov. 16	Product Showcase—Vol. I, Power Sources, Software	Closing: Nov. 21 Mailing: Dec. 15
Dec. 22	Dec. 1	Product Showcase—Vol. II, Computers & Peripherals, Test & Measurement	

Call today for information:

East Coast: Janet O. Penn (201) 228-8610
West Coast: (213) 826-5818
National: Roberta Renard (201) 228-8602

Great Memories are Made in America

Call for private interview
Semicon East, Boston
Sept 12-16

Join The American Team

At Micron, we're committed to making American-made memory products the standard of the industry, and as part of our team, you'll work on the leading edge of sub-micron, multi-megabit technology. Located in the beautiful foothills of Boise, Idaho, Micron offers a state-of-the-art environment — both on and off the job — and a quality of life, and diversity of recreational opportunities, that equals the quality of our products. Make a memorable career move and choose Micron — the team that makes great American memories.

Engineering Opportunities

- Device Physics
- Thin Films
- Implant
- Analytical Chemist
- E-Beam and Optical Lithography
- Field Applications
- Test
- Product
- QA/FA
- Material Science
- Modeling/Simulation/Characterization
- PVD
- Dry Etch
- CVD

Research & Development Projects

- Planar Sub-Micron Contacts/Vias
- Sub-Micron CMOS Transistors
- Reliable Metal Interconnect
- Source, Drain and Poly Self-Aligned Silicide
- Local Interconnection
- E-Beam Direct Exposure Systems
- Aggressive N+/P+ Space
- High Pressure Oxidation
- Rapid Thermal Processing
- Multi-Level Metalization
- Ultra-Clean Technology
- Advanced Metrology
- Hi-Energy Implantation
- Ultra-Thin Dielectric Technology
- 3D Technology
- Zero SER Technology
- Facility Automation

Production

- CMOS DRAMS (256K, 1M, 4M, 16M)
- Fast SRAMS (16K, 64K, 256K, 1M)
- High Density Video RAMS (256K, 1M)
- Customer Supplied High Density Logic for use in Rel Sensitive Applications
- ASM Memory

Reliability Qualification

- Advanced Smart Burn-In Capability
- 5 Million Device Hours Per Day/
Per Part/Per Process
- Full Process/Product Qualification

MICRON

TECHNOLOGY, INC.

MICRON TECHNOLOGY, INC., 2805 E. COLUMBIA ROAD BOISE, IDAHO 83706 (208) 383-4038
AN EQUAL OPPORTUNITY/AFFIRMATIVE ACTION EMPLOYER



There are lemons an

In today's job market, there is a big difference between jobs available, and the long-term career opportunities that those jobs represent. At FMC, a job opening represents a career future with the world's leading designer/manufacturer of military tracked vehicles. Our staff works daily on the leading edge of new technologies and advanced management and accounting systems. There are plenty of "peaches" when it comes to career openings at FMC. If you qualify, why not pick one for yourself?

ENGINEERING

(When writing in response to the career opportunities listed in this category, please use address listed below, attention: ENGINEERING)

Software Engineer

You will perform software engineering development and assist in the development of software engineering standards. A BSEE or BSCS is required, along with proficiency in Ada, PASCAL, or C, recent assembly language programming experience, and knowledge of military R/T embedded software systems. U.S. Citizen.

Staff Engineer — Fire Control Systems

You will analyse, design, and integrate fire control systems including target acquisition systems,

turret drive and stabilization systems, and weapon control elements. Prefer MS in ME, EE, or related technical field. U.S. Citizenship is required. Six to eight years combined experience is required in the areas of control system design, electro-optical system design, and microprocessor applications.

Electro/Mechanical Packaging Design Specialist

You will analyse and design E/M packaging concepts to support product development. Ten years experience is required in military packaging design, including knowledge of military specifications. BSME or BSEE or equivalent experience is required, as is U.S. Citizenship.

Staff Engineer — Technical Leader — Dynamics and Controls

Supervisory position, PhD preferred in ME with 5 years experience in dynamics and controls. Experience in rigid body analysis, testing, and thermal and finite element analysis is desirable. U.S. Citizenship is desirable, not mandatory. This position requires the ability to lead several projects in different engineering fields.

Engineer — Simulation

This senior level applications and IR&D position focuses on


the areas of simulation, modeling, and computer graphics development. A PhD is preferred in engineering, math, or computer science. Also desirable is experience with the IRIS workstation, animation development, FEM, and simulation programs such as DADS. U.S. citizenship is desirable.

Electrical Engineers

We have openings at two experience levels: two years minimum and 5 to 10 years. You will provide IR&D support to a variety of projects in these areas; logic analysis, digital design and microprocessor interface, A/D system analysis, control system design and specification, and R/T SW programming. U.S. citizenship required.

Staff Engineer — Acoustics and Vibration

We have an opening for a Mechanical Engineer with a strong background in acoustic testing and analysis. Knowledge of dynamic/modal analysis,



There are peaches...

st instrumentation, and noise and vibration control is required. This senior position requires even years experience in testing and digital signal analysis, and a PhD in ME is preferred. U.S. citizenship is required.

TECHNICAL COMPUTING

When writing in response to the career opportunities listed in this category, please use address listed below, attention: TECHNICAL COMPUTING)

RE

seeking qualified candidates with two to five years experience in FORTRAN programming or interactive VAX/VMS software. BSME requirement as well as C programming in UNIX environment.

UNIX System Administrator

Qualified candidates for this position must have a BS in Computer Science in addition to three to five years experience in Systems Management. Knowledge of VMS is helpful — three to five years experience in C and FORTRAN is a must.

RAMIS Programmer

seeking qualified candidates with two to five years experience developing systems with

RAMIS. Experience also required in IBM MVS, JCL, CLIST, and SQL. Candidates must have experience in development of internal and external file structures as well as menu based systems.

CV / CADD System Administrator

This position is responsible for the operations and support of Computervision CADD4X Systems. BS in Computer Science with at least 3 years experience with CV/CADD System Management, knowledge of CADD4X/CGOS environment is required. SUN/UNIX systems knowledge is desired.

MANUFACTURING

(When writing in response to the career opportunities listed in this category, please use address listed below, attention: MANUFACTURING)

Industrial Engineer

B.S. degree in Industrial Engineering or Industrial Technology. Substantial knowledge of manufacturing processing in at least one of the following areas: forming and bending, machining, welding, heat treat, chemical processing and painting. Analyze and interpret engineering drawings and

specifications for production application. Estimate all standards for bids and production floor operations. 2 to 3 years experience required.

Quality Control Engineer

B.S. degree in Engineering, Industrial Technology, or Quality Assurance. Five years minimum experience in a Quality Engineering function with a strong working knowledge of MIL-Q-9858 and MIL-STD-1520. Involves extensive investigation of failure analysis and problem resolution. Must possess good verbal and written communication skills in interactions with customer representatives.

FMC offers an excellent salary and a comprehensive benefits package. For prompt consideration please send resume, including your salary history and requirements addressed to either Engineering, Technical Computing or Manufacturing at: FMC Corporation Ground Systems Division, 328 W. Brokaw Road, P.O. Box 58123, Dept. 17-88-05, Santa Clara, CA 95052. We are an Equal Opportunity Employer.

There are jobs and there are careers.



ARE YOUR IDEAS AHEAD OF OUR TIME?

Stonehenge, one of the most famous of all the classical megalith monuments, has long been an important part of the popular and scientific imagination. Its origin has been the cause of speculation for years, as scientists try to discern who had the intellect and ingenuity to create a celestial observatory of such astronomical significance and exactness.

What is clearly understood and shared these 4,000 years later is man's unceasing fascination with the heavens and his need to explore them for a better understanding of his place in time and space.

The construction of Stonehenge required remarkable genius and ability — and so will the endeavors we have planned at General Dynamics Space Systems Division.

You can now be a part of our exciting time in history. Your ideas and accomplishments could be chronicled for future generations to study as hallmarks of a brilliant epoch in space exploration.

We currently have opportunities available in the areas listed below for individuals with a technical degree or the equivalent combination of formal education and related experience. Government or aerospace industry background is preferred. If you are interested in one or more of these areas, please send your resume to: Professional Staffing, GENERAL DYNAMICS SPACE SYSTEMS DIVISION, MZ C2-7143-I252, P.O. Box 85990, San Diego, CA 92138.

(Opportunities also exist in Huntsville, AL and Harlingen, TX.)



AVIONICS

- EMI/EMC
- Electrical Power
- Instrumentation
- RF Systems
- Parts Engineering
- Harness Design/Installation
- Liaison
- Analog/Digital Circuit Design
- Avionics Systems
- Mechanical Packaging
- Control Systems
- Guidance & Navigation

QUALITY ENGINEERING

- Tool Design/Proofing
- Software Quality Assurance
- Process Control
- Radiographic Inspection

FLUID SYSTEMS DESIGN

- Pneumatic
- Hydraulic
- Propulsion
- Cryogenics

STRESS ANALYSIS

- Hand Analysis
- Finite Element Modeling
- Structural Test Support
- CAE
- Methods
- Advanced Composites

SYSTEMS

- Systems Requirements
- Systems Safety
- Environmental Engineering
- Security Engineer
- Software

STRUCTURAL DESIGN

- Advanced Composite Structures
- Tank Structures
- Adapters
- Fairings
- Materials & Processes
- Pre-Design
- Mechanical Liaison
- Superconducting Magnets
- Drawing Checkers

DYNAMICS/ANALYSIS

- Launch Vehicle Transient Load
- Environmental Dynamics
- Acoustics
- Jettison Trajectory
- IRAD & CRAD
- CAE

THERMAL/FLUIDS ANALYSIS

- Systems Modeling
- Space Environments
- Propulsion
- Cryogenics

TEST & EVALUATION

PROCUREMENT

SCHEDULING

PRODUCTION

ENVIRONMENTAL/HAZARDOUS WASTE ENGINEERING

GENERAL DYNAMICS

Space Systems Division

Equal Opportunity Employer Principals Only

OUR VICTORIES ARE AT SEA, ON LAND AND IN SPACE.



Careful strategic planning has provided Martin Marietta with the diversified and solid contract base needed to thrive in the years to come. Some of the contract victories won by Martin Marietta and being worked on at Aero & Naval Systems in Baltimore, are the Vertical Launching System, MK 50 Torpedo, Titan and WAA.

Other current program activity includes work in:

- **Autonomous Underwater Vehicles**
- **Advanced Lightweight Sonar**
- **Remotely Piloted Air Vehicles**
- **ASW Research & Technology**
- **Surface Weapons Systems**
- **Combat Systems Engineering**
- **Robotics**

These and other exciting projects require us to seek out experienced engineers with a technical MS/PhD or at least one year experience in:

Manufacturing Engineer

- Machine Shop Planner
- Cutter Specialist

Production Control

- Planners
- System Programmers

Systems Engineering

- Requirements Definition
- Integration Testing
- Test & Evaluation
- EMI/EMC Definition
- Systems Test Requirements
- Interface Integration

Systems Analysis

- Operations Research
- Simulation & Modeling
- Mission Analysis
- Sensor Performance

Software

- Discrete Simulation
- ATE Software Design
- State Table Design
- Test and Evaluation
- Autonomous Underwater Vehicle Software

Robotic Systems

- Telepresence
- Supervisory Vehicles
- Manipulator Design

Electronics Engineering

- Power Systems
- Microprocessor Applications

- VLSI Design
- ATE/Teradyne
- Analog & Digital Design

Mechanical Engineering

- Naval Architect
- Noise Control Engineer

Logistics Engineering

- Systems Safety

Advanced Manufacturing Technologies

- Materials Engineers
- Electronic Process Engineer
- Welding Engineer

We also have opportunities for these professionals:

- **Sr. Subcontract Administrators**
- **Configuration & Data Management Specialist**
- **Contract Administrators**
- **Master Program Planners**
- **Pricing Analyst**
- **Cost Management Administrators**

Please send your resume to:
Martin Marietta Aero & Naval Systems, Employment Dept.
SourceX293, 103 Chesapeake Park Plaza, Baltimore, MD 21220. An equal opportunity employer m/f/h/v.

MASTERMINDING TOMORROW'S TECHNOLOGIES

MARTIN MARIETTA

SYSTEM ENGINEERING

GE is looking for Systems Engineers who would rather create tomorrow's standards than follow them.

System Engineering

If you're a Systems Engineer who will not accept the notion that something can't be done because it's never been done before...you belong at GE System Engineering. Currently, GE technical professionals have taken a lead role in the design, development and integration of some of the nation's most sophisticated advanced-technology systems. This leadership role has prepared us for one of the most important engineering challenges of our time. With the announcement of contract award for the Strategic Defense System (SDS) System Engineering, we have openings across a broad spectrum of System Engineering programs as we assign engineers to this key national program.

Help us do what GE does best...

If you are intrigued with the idea of working years in advance of current technology with some of the industry's leading engineering professionals, you should consider a career with GE System Engineering. Positions are available with our operations across the United States including **VALLEY FORGE, PA, WASHINGTON, DC, HUNTSVILLE, AL, COLORADO SPRINGS, CO AND LOS ANGELES, CA.**

The GE System Engineering Team.

Communications Engineer
Systems Engineers
Mathematical Modeling
Electro Optics
Radar Systems
Kinetic Energy Systems
Guidance Systems
Space Systems
Battle Management
Missile Systems
Systems Architecture/Requirements Definition
System Simulation
Survivability/Vulnerability
Spacecraft Systems Engineers
Ground Station Systems Engineers
Operational Systems Engineers
Launch Operations Engineers
System Requirements Engineers
Mission Analysis Engineers
Advanced Systems Engineers
Communications Systems Engineers
Control Systems Engineers

Systems Serviceability Engineers
Senior EMI/EMC Engineers
Radiation Effects Engineers
Interface Development Engineers
Configuration Control Engineers
Program Control Engineers
System Verification Engineers
System Test Engineers
Reliability/Availability Engineers
RF Engineers
Antenna Systems Engineers
Structural Dynamics Engineers
Power Systems Engineers
Software Systems Engineers
Data Systems Engineers
Computer Systems Engineers
Information Systems Engineers
System Analysis Engineers
Command & Control Systems Engineers
Simulation Engineers
Orbit Analysts
Trajectory Estimation Analysts

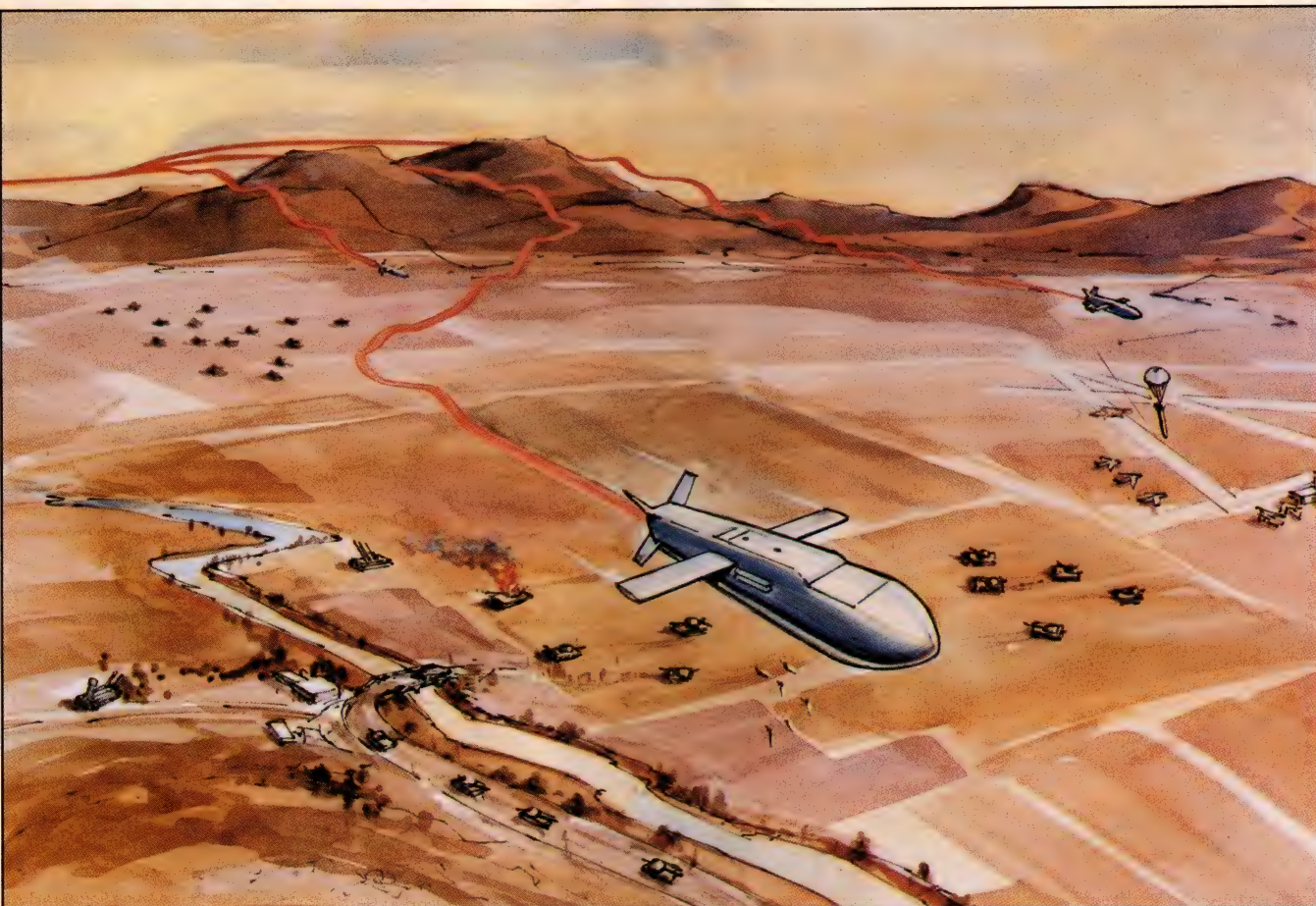
The rewards for accepting the GE challenge.

GE offers an excellent salary and benefits package as well as continued opportunities for technical and management development. For immediate consideration please forward your resume, indicating your geographic preference (**VALLEY FORGE, WASHINGTON, HUNTSVILLE, COLORADO SPRINGS, LOS ANGELES**) to: **GE SYSTEM ENGINEERING, 780 5th Avenue, King of Prussia, PA 19406.**



System Engineering

An equal opportunity employer



Now there's a new name for emerging technologies:

Textron Defense Systems **Advanced Systems/Technology Center**

Managers, Scientists, System Engineers, Design Engineers and Component Engineers

Shape a new future with us

Work in: **Advanced Strategic Vehicles • Brilliant Munitions • Penetration Aids/Decoys**

With specific involvement in:

MISSION ANALYSIS

- Strategic Systems
- Tactical Systems

SENSOR SYSTEMS

- Electro-optics/Detectors
- RF/MMW/Antennas
- Seismic/Acoustics
- Signal/Imaging Processing
- Artificial Intelligence

SYSTEMS

- Guidance/Control
- Warheads/Penetrators
- Pointing/Tracking
- Vehicle Dynamics

RADAR/OPTICAL OBSERVABLES

- Threat Definition
- Materials
- Aero-Physics
- Microelectronics
- Software

Textron Defense Systems combines the strength of superior resources with advanced design, research and manufacturing achievements. We offer people with talent, leadership and imagination the unique opportunity to put their best ideas into action. We are able to support outstanding performance in every way, from advanced design tools to our leading edge technical commitment.

These positions require educational levels from BS to PhD in a technical discipline and upwards of 3-15 years related experience. All openings require U.S. citizenship. For consideration please forward your resume to: Paul Smith, 3 AV 14 Textron Defense Systems, 201 Lowell Street, Wilmington, MA 01887. An equal opportunity employer

TEXTRON Defense Systems

A Tale of Two Cities

Join the engineers working on the AN/BSY-2
...the remarkable, fully integrated combat system
for the Navy's new SSN-21 Seawolf



With One Mission.

SYRACUSE, N.Y.

At GE Government Electronic Systems Division in Syracuse, we're taking undersea technology to new heights. And you can be part of it.

Exciting positions are now available to work on the SSN-21 Seawolf submarine project...developing systems architecture and providing overall program management for the AN/BSY-2. This marvel of sensor, processing and command hardware and software is our greatest achievement yet, confirming our position as a world leader in sonar and ASW.

Surface ship acoustic technology is another area of GE leadership in which we have a whole range of challenging opportunities.

To be part of this tremendous effort, see if you qualify for one of the following positions.

Software Architecture

Requires 7+ years experience in large systems design involving embedded programmable processors (68000 or similar processor). Familiar with top down structured design in ADA or Fortran.

Combat Systems Engineering

Requires 5+ years in analysis, design and development of large scale shipboard ASW systems. Must be knowledgeable in weapons control systems engineering, reliability/maintainability and human factors.

Acoustics/Signal Processing

Systems engineers with 5+ years design experience involving towed and remote sonar arrays. Sensor systems design and algorithm development are key requirements, also target motion analysis.

Sonar Array Hardware

Project engineers with 8+ years experience in advanced architecture and design of sonar hardware. Will lead a development team in all related functions: wide aperture array design, transmitter design, electronics packaging, cabinet design, simulation and modeling, etc.

Program Management

Must have 10+ years in-depth experience in ASW systems development. Broad ranging software/hardware knowledge. Experience in large program prime contractor environment. Subcontractor management experience.

Software Quality Assurance

Software engineers with 7+ years military electronic systems experience, including knowledge of MIL-S-483/2167/2168.

GE's compensation is outstanding, including a competitive salary and benefits package, plus extensive in-house technical and management training. Then there's the city of Syracuse—located in a pastoral lake setting, and featuring a wide range of cultural, recreational, and lifestyle options.

To apply to GE, send your resume, indicating areas of professional interest, in confidence, to:

GE Company, Professional Staffing, CODE ADEDN, PO Box 4840, EP-1-106, Syracuse, NY 13221. U.S. Citizenship Required.

MOORESTOWN, N.J.

Deep thinking continues at RCA Electronic Systems Division in Moorestown, where our top-notch team of engineers continue to make major contributions to the design of the AN/BSY-2...a fully integrated combat system.

This highly impressive hardware/software with superior automated command/communication functions and unsurpassed time saving data information processing, represents some of the most sophisticated ASW technology ever developed for the U.S. Navy.

The specific positions now available will afford engineers the opportunity to work on these vital system challenges for the SSN-21 Seawolf...the submarine of the future. See if you qualify for one of the following positions.

Senior Engineers, Combat Control

- BSEE
- 5+ years in Combat Control performance definition, design and test for real time Combat Control Systems.
- Knowledge of U.S. Navy systems, preferably submarine systems.

Senior Digital Design Engineers

BSEE, with 5+ years experience in the digital/firmware design of digital sub-systems. Should also have experience in the design of special purpose digital processors with strength in current custom design and simulation techniques.

Senior Software Design Engineers

BSEE or BSCS with 5+ years direct experience in the design and development of large real time Command and Control Systems which utilize sensor data input. Experience with the following:

- Fault location/fault detection with a plus for automatic configuration design experience.
- Real-time data base design experience with Ingress or Oracle.
- Motorola 68020 assembly language, and/or real time operating system experience.

Senior Engineers, Command & Decision

BSEE with 5+ years in Command and Control performance definition, design and test for real time Command and Control Systems. Should have knowledge of U.S. Navy systems, preferably submarine systems.

At RCA your engineering foresight and technological expertise are rewarded with an outstanding salary and benefits package including dental, tuition, and two on-site master's degree programs. Our location in Moorestown, NJ is a pleasant suburban environment just 15 miles outside of Philadelphia with close proximity to leisure activities of the shore and mountains. For confidential consideration, forward your resume to: **Mr. Herman C. Ford, RCA ESD, Bldg. 127-102, Moorestown, NJ 08057. U.S. Citizenship Required.**

GE Aerospace

GE Government Electronic Systems

ENGINEERS

Find excellence in action at the Government and Defense Group of Emerson Electric. Here's who we need:

SOFTWARE GROUP & DESIGN ENGINEERS

Perform real-time signal processing software development with 6809, 68000 or 68020 microprocessors. BSEE or BSCS and 3 years experience in one or more of the following are required: VAX, VMS, 1750A, FORTRAN, ADA, JOVIAL, FORTH, ROLM, ATLAS or ASSEMBLER. Previous supervisory experience preferred.

SENIOR SYSTEMS ENGINEERS

Develop systems and subsystems, test requirements, and design validation. Requires specialization in anti-armor launching, fire support or target acquisition and the ability to communicate requirements to design engineering. BSEE and 5 years in optics, electro-stabilization, electronic design, or real-time software are desirable.

BUSINESS DEVELOPMENT ENGINEERS

Radar and Armament Systems

Break new ground in optics, electro-optics, laser, radar, and land navigation products and programs.

Requires BSEE (MSEE/MBA preferred) and 10 years experience with all aspects of anti-armor

missile launching and guidance systems and/or fire support target acquisition systems. Prior military experience would be a definite plus.

SENIOR TEST ENGINEER

Perform environmental and functional test planing, preparation, and conduct tests; design test fixtures, setups, and write test plans; and have lead responsibility for test programs. Position requires 5 years related experience with MILSPECS and formal documentation in analog, digital and RF systems.

SENIOR STAFF ENGINEER (POWER)

Generate, implement and monitor EMI, NEMP, ESD plans for electronic programs. Provide source data for filter procurement specs. MSEE or Applied Physics and 10 years specialized experience with MILSTD-461 and 462 EMI Control required. NEMP and nuclear effects experience desired.

DIGITAL DESIGN ENGINEERS

Requires BSEE and 5 years experience either designing control units, or working with real-time computerized signal processor and image processing with radar interfacing. Design experience with VHSIC and/or ASIC desirable.

To explore these opportunities, please send your resume in complete confidence to:

Steve Borgmeyer
Emerson Electric Co.
Mail Station 4690—EDN
8100 W. Florissant Avenue
St. Louis, MO 63136

EMERSON ELECTRIC CO. Government & Defense Group

An equal opportunity employer. U.S. citizenship is required for some positions.

NATIONWIDE 2000 OPENINGS ENGINEERS MANAGEMENT

Salaries from 30K-100K
exclusively employer fee paid
These current openings need
to be filled now

Please send your resume
today to:

Personnel Recruiting
&
Placement Association
16 W. Pacific Ave., Suite 9
Henderson, NV 89015
OR
2020 Cheviot Hills Dr.
Springfield, OH 45505
OR
3824 Barrett Dr.,
Suite 205 (A)
Raleigh, NC 27609
(702) 564-9007

Photonics

We are actively engaged in digital optical computer, analog optical processing, integrated optical/opto-electronic devices and optical communication LAN R&D. Join us. Send your resume to Boeing, P.O. Box 3707-R53, Seattle, WA 98124.

Equal opportunity employer.

BOEING

ELECTRONICS • AEROSPACE NATIONWIDE \$30-80K

Opportunities for Engineers & Professionals in Defense/Aerospace and Commercial Industries. Send Resume to:

JACK PORTER ASSOCIATES, INC.
385 Front St. N., Issaquah, WA 98027
(206) 455-4928

All fees paid by client companies.

Adventure & Discovery in Aerospace & Defense

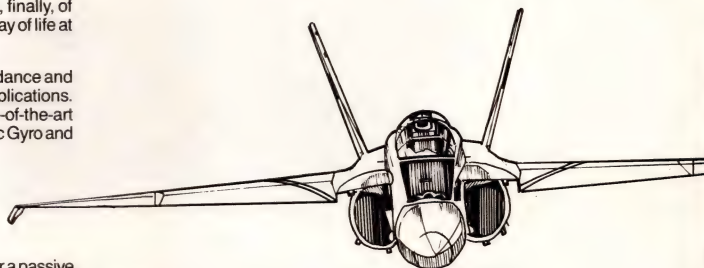
Engineering breakthrough. It's a process of exploration, of inspiration, and, finally, of triumph. It takes the right combination of technology and people. And it's a way of life at Smiths Industries, SLI Avionic Systems Corporation.

We are one of the world's premier manufacturers of aircraft instruments, guidance and navigation systems and flight data recorders for commercial and military applications. Building on a 40+ year history of leadership, we are today involved in state-of-the-art attitude heading reference systems technology (AHRS), including a Fiber Optic Gyro and Strapdown Inertial Navigation Systems.

Join us at our Grand Rapids Operation in one of the following challenges:

Guided Wave Optics Engineer

Senior position responsible for augmenting optical rate sensor development for a passive Fiber Optic Gyro. Requires solid hands-on development experience in single-mode guided wave optics. Proven leadership, communication, organizational and analytical abilities are a must. MSEE or MS Physics with applied electro-optic orientation required; PhD preferred.



Senior Software Engineer

Requires 5+ years experience in real-time, embedded, computer-based system development, involving system requirements specification, architecture design, function design and programming. Knowledge of formal development methods and the DEC VAX/VMS environment is essential. Familiarity with CASE tools is preferred, as is teaching/ training experience. Advanced degree in Computer Science or Electrical Engineering desired.

DTS Engineer

You must possess at least 5 years experience with data transfer systems, and a strong digital hardware background involving microprocessors. You must be able to write software requirement specifications, and to analyze system software/ hardware trade-offs. Presentation and communication skills are essential. BSEE or equivalent.

Process Engineer

You will be instrumental in improving yields and capabilities in circuit board assembly. Requires an Engineer with process experience (wave solder, touch-up, coating, etc.)

Electromechanical Manufacturing Engineer

Your responsibilities in our dynamically tuned gyro area will demand strong electro-mechanical skills.

Producibility Engineer

Our producibility improvement/cost reduction team will make full use of your expertise.

Logistics Engineer

Requires a minimum of 3 years logistics planning experience for avionics equipment, with knowledge of the LSA process, MIL-STD-1388 LSAR database, and military logistics/acquisition or USAF concepts. BSEE or equivalent.

Smiths Industries offers a salary and benefits package you'd expect from a leader. We will provide relocation assistance to our attractive community in western Michigan, which offers a below-average cost-of-living and proximity to endless recreational activities. For consideration forward your resume and salary history, indicating the position in which you are interested, to:

Judy Percy
Manager of Technical & Professional Staffing
SMITHS INDUSTRIES
SLI Avionic Systems Corporation
Grand Rapids Operation
4141 Eastern Ave., SE
Grand Rapids, MI 49518-8727

Reliability Group Manager

You will manage reliability design engineering and product support activities, as well as failure analysis lab functions. Requires a minimum of 7 years related experience, including some at the supervisory level. BSEE or BS Physics expected.

Senior Reliability Engineer

Project coordination responsibilities in engineering and product support. Requires a minimum of 5 years related experience, and strong leadership and communication skills. You must be familiar with FMEAS, MIL-Specs, and reliability modeling, predictions and testing. BSEE or BS Physics necessary.

Mechanical Engineer

Your challenges will demand at least 6 years experience in the design, development and testing of dynamically tuned gyros, with an orientation toward project responsibility. BSME required.

Staff Engineer

Sales support engineering will be among your challenges. Requires systems project technical experience in the design, development and testing of Strapdown Inertial Navigation Systems. Strong math and analytical skills are a must. BSEE necessary.

Materials Engineering Section Manager

Requires 7+ years experience, to include some at the supervisory level. Materials engineering experience in an aerospace instrument or electronic systems environment is preferred, with knowledge of printed wiring board fabrication and assembly, metal finishing, heat treatment and general metallurgy. BS in Metallurgy, Chemistry or Materials Science expected.

Senior Data Systems Engineer

Qualifications include a minimum of 5 years experience in military avionics system design, with strong hardware and software experience. You must be familiar with MIL-490 and MIL-2167 system requirements documentation; background in structural analysis is preferred, as is the ability to formulate interface control documents, white papers, proposals, etc. BSEE or equivalent.



Semiconductor Professionals

Join Us At The Leading Edge Of Semiconductor Technology

The **Harris Semiconductor Custom Integrated Circuits Division**, located in Melbourne, Florida, develops and manufactures custom and semicustom integrated circuits for military use in the strategic, tactical and space environments. Particular emphasis is placed on radiation hardened, high performance, high reliability and classified applications. Our capabilities include bipolar, digital and analog; CMOS digital and analog; and combinations of these technologies on the same integrated circuit. We currently have outstanding opportunities available for semiconductor professionals in the following areas:

Assembly Engineering

You will provide process engineering support to hi-rel assembly operations. Responsibilities will also include developing, monitoring and writing applicable specifications for yield enhancement. To qualify, you should have a BS in Chemical or Electrical Engineering and a minimum of 2 years' related experience.

Product/Test Engineering

You will provide product and test engineering support to ASIC product development activities. You will also provide test programs, evaluate test hardware and test program debug correlation evaluations. To qualify, you should have a BS in Electrical Engineering and a minimum of 2 years' ASIC product and/or test engineering experience. In addition, experience in Automated Test Program Generation (ATPG) would be a plus.

ASIC Field Design Engineering

You will provide front end design support at field offices and customer locations. You will also assist customers in the use of Harris design tools and CAD capabilities. **Positions available are in northern and southern California, Southeast U.S. and Northeast U.S.** To qualify, you should have a BS in Electrical Engineering or Computer Science and a minimum of 4 years' related circuit design experience. In addition, experience with cell-based or custom design automation tools is highly preferred.

Reliability Assurance Engineering

You will evaluate reliability characteristics of new processes by providing test structure designs, test procedures, data analysis techniques, failure mechanism models, and development of reliability design rules. An MSEE with an emphasis in solid state physics and a minimum of 2 years' related engineering experience are preferred. Experience in reliability theory, statistical analysis and modelling techniques is highly desired.

As part of the Fortune 200 Harris Corporation, Harris Semiconductor offers an excellent compensation/benefits package and relocation assistance. For immediate, confidential consideration, please forward your resume, including salary history, to: Joe Clark, Professional Staffing, Harris Semiconductor-CICD, Dept. ED/0818, MS 53-002, P.O. Box 883, Melbourne, FL 32901. We are an equal opportunity employer M/F/H/V.

Principals only--no agencies please.



HARRIS

We Offer You
**REAL-WORLD
 OPPORTUNITIES**
 In A
**DOWN-
 TO-EARTH
 COMMUNITY.**



Imagine a friendly, education-centered, family-oriented community of neighborhoods through which you enjoy a hassle-free, scenic drive to work in your new position. Imagine a 17-year-old sophisticated technology systems company where potential is transformed into performance—every day!

You've arrived in LANCASTER, PENNSYLVANIA, where the opportunities are real with ISC Defense Systems, Inc. And when you join us, you become part of a \$1.5 billion international corporation. Imagine what we can do for your career and your lifestyle! Explore these opportunities in military electronic defense systems:

Manager/New Systems Business Development
Manager/Solder Assembly Technology
Operations Program Manager
Manager Test Engineering
Systems Engineer—Fuze/Radar
Ordnance Fuzing Engineers
Manager/Manufacturing Engineering
Project Engineer—Digital Systems

Manager of Finance
Manager QA Engineering
Software & Digital Systems Design Engineers
Sr. QA Engineers
Sr. Manufacturing/Process Engineers
Mechanical Inspection Quality Engineers
Supplier QA Engineers
Configuration Management Specialists
Contract Administrators

Lancaster County, known for its quaint Amish influence, is home to an increasing number of high technology companies due to a stable and diverse economy. The area offers a surprisingly affordable cost of living, and is located within 2 hours of our Nation's Capital, Baltimore and the Chesapeake Bay. To find out more about our Real-World Opportunities and our enviable location, send your resume to: **Andrew Peters, Manager—Professional Resources & Employment/EDN, ISC Defense Systems, Inc., 3725 Electronics Way, P.O. Box 3025, Lancaster, PA 17604-3025, 1/800-ISC-3725**

U.S. Citizenship Required; Equal Opportunity Employer.

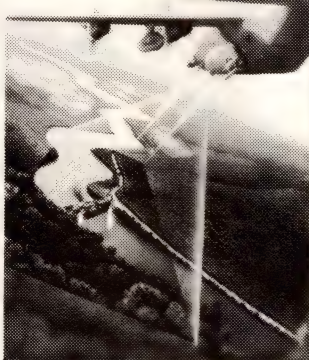
ISC DEFENSE SYSTEMS, INC.

MEMBER OF ISC DEFENSE & SPACE GROUP

**A new low light
level TV sensor
for the
AC-130U
Gunship.**

**Who's
building it?**

Ball Corporation.



Ball specializes in delivering advanced sensor and communications systems for tactical and strategic applications: Mast-Mounted Sight cameras for the Army's advanced helicopter improvement program, sensors for the Navy's Seasparrow program, antennas for Harpoon missiles. We're on a team to design the Navy's mid-range RPV.

Ball's aerospace heritage and tactical expertise are an unbeatable combination for military systems. Our rapidly growing tactical products group is a key ingredient in our company's new business endeavors and offers engineers premier facilities, innovative technology, and career opportunities. Become part of our success and enjoy competitive salaries and benefits.

Ball opportunities for engineers and managers span a wide variety of technologies needed for the development of airborne and spaceborne hardware for DOD and NASA programs.

- **Senior Mechanical Design**
(Structures, Pointing Systems and Mechanisms)
- **Senior Electronic Design**
 - Servo Control
 - Micro Processor
- **Senior Electronics Optical System Engineer**
- **Senior Tactical Systems Engineer**
- **Electro Magnetic Analyst for Antenna Design**
- **RF Design**
- **Senior DOD Program Manager for Large Instruments**
- **Senior Optical Engineers**
- **DOD Marketing**
- **Electronic Optics Design**
- **IR Sensor Systems**
- **Hardware Systems Safety**
- **Reliability**
- **Spacecraft Systems**
- **Senior Spacecraft Systems Test**
- **Senior Signal Processing Engineer**
- **Senior Software Engineer**

Send your resume to Ball Aerospace Systems Group, Human Resources, Dept. 53761, P.O. Box 1062, Boulder, Colorado 80306, or call 1-800-678-9030.

Equal Opportunity Employer
No Agencies Please
U.S. Citizenship Required



**Aerospace
Systems
Group**

Excellence, Our Legacy and Our Future.

THE EDN MAGAZINE/EDN NEWS

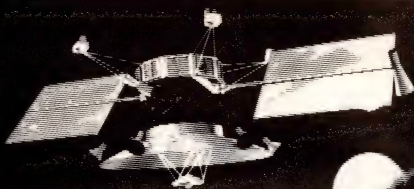
Recruitment Package

**The most cost-effective way to reach
the most professionals!**

EDN reaches more than 137,000 engineers and engineering managers, the largest circulation in the electronics field. EDN News reaches EDN's U.S. circulation of more than 121,500. And, when you place equivalent space in both the *Career Opportunities* section of EDN, and the *Career News* section of EDN News in the same month, you'll get a 1/3 discount off the EDN News rate!

EDN MAGAZINE/EDN NEWS
Where Advertising Works.





DISCOVERY

At JPL, we're applying many of our sophisticated technologies, developed for Space, to defense projects here on earth. These involve C³I Systems, remote sensing, and tactical battlefield information and simulation systems.

We have positions available in the defense program areas for U.S. Citizens with Bachelor's, Master's and PhD degrees, who have a minimum of four years' related work experience.

INFORMATION SYSTEMS

- **TACTICAL COMMUNICATION SYSTEMS ENGINEERS** — manage and implement secured message processing software development.
- **SYSTEM SOFTWARE MODULE DESIGNERS** — negotiate and define security requirements for systems software modules.
- **CONTRACT MONITORS** — monitor and interface with contractor on design, implement, and test of the Functional Data Manager.
- **COGNIZANT SYSTEMS ENGINEERS** — design, code and test software and managing software development contract.
- **VAX INTERNALS PROGRAMMERS** — manage contracts for ruggedized fielded computer systems.
- **REAL-TIME PROGRAMMERS** — design and develop real-time software.
- **MAN/MACHINE INTERFACE DESIGNERS** — design and implement man/machine interface software.

SYSTEMS

- **SYSTEMS ENGINEERS** with experience in operational analysis requirements, development and operational concept development for C³I tactical intelligence operations.
- **SYSTEMS ENGINEERS** — technical monitoring and implementation of subcontracts.
- **SYSTEMS ENGINEERS** with experience in system level design and implementation trade-offs.
- **SYSTEMS ENGINEERS** with experience in Configuration Management development of documentation and modification process.
- **SYSTEMS ENGINEERS** with understanding of system level RAM and FMECA issues.
- **MISSION/REQUIREMENTS ANALYSTS** with experience in analysis of military information systems requirements.
- **SOFTWARE SYSTEMS ENGINEERS** with experience in defining requirements, top-level design and requirements allocation to lower levels and Mil Spec documentation.
- **PERFORMANCE ANALYSTS** with experience in performance system modeling and analysis of large data systems including performance measurement and prototype software development.
- **HUMAN FACTORS ENGINEERS** with experience on large scale data systems in the area of operator-computer, interface, screen display guidelines and data flow thread analysis.
- **SOFTWARE SECURITY ENGINEERS** — design and implement secure multi-level systems including formal verifications and DIA accreditation.
- **DATA ANALYSIS ENGINEERS** — design and certify secure computer systems.

QUALITY ASSURANCE

- **SOFTWARE PRODUCT ASSURANCE ENGINEERS** with experience in performing system and software requirements, design, implementation and testing analysis.

Please send a resume to **Professional Staffing, Dept. U73, Jet Propulsion Laboratory, 4800 Oak Grove Drive, Pasadena, CA 91109.** An Equal Opportunity Employer M/F.

JPL

Jet Propulsion Laboratory
California Institute of Technology

SAIL AHEAD ON THE WAVE OF TECHNOLOGY

Join the Winning Team! Become a part of SGS-Thomson Microelectronics — a new company with over half a century of semiconductor experience. SGS-Thomson is ranked 13th in the world, second in Europe and 14th in the United States.

The Carrollton (Dallas), Texas based facility is expanding and has immediate needs for engineers and technicians who have semiconductor experience. Some of the openings are as follows:

Process Engineering

Two plus years of previous experience in areas of plasma etch, photolithography, sputter metalization or CVD.

Equipment Engineering

Repair and maintenance experience on wafer processing systems.

Device Engineering

Knowledge of 1.2 micron products and ability to oversee fab improvement activities.

Wafer Fab Technical Supervisor

Technical degree with wafer processing experience.

Design

Two plus years of Integrated Circuit design experience.

Product Marketing

BSEE with two plus years semiconductor or systems marketing experience.

Application And New Product Definition

Responsible for defining new products for memory and datacommunications markets.

Sales Engineers

Technical degree with semiconductor experience.

Marketing and sales positions are also available at our Phoenix, Arizona facility.

If you wish to become part of a dynamic, expanding organization, please send your resume to: **SGS-Thomson Microelectronics, Employment Manager, Department E003, 1310 Electronics Drive, MS776, Carrollton, TX 75006.** Principals only, please. An equal opportunity employer m/f/h/v.

SGS-THOMSON
MICROELECTRONICS

Job-hunting shouldn't be a wild goose chase.

Running all over town for interview appointments is for the birds. BPI TECH FAIR® lets experienced engineers, computer, DP/MIS or software professionals interview with dozens of companies at one time. In one place.

Each BPI TECH FAIR brings recruiters and line management from top local and national technical companies to your area. They're looking for experienced professionals like you. You'll get a chance to meet with many companies. Learn about other career opportunities. And save yourself a lot of time.

BPI TECH FAIR is completely confidential. There's no registration. *And we're not an employment agency.* So there's no fee.

If you're an experienced engineer, computer, DP/MIS or software professional, plan to attend the next BPI TECH FAIR. We'll take the hunt out of your job hunting.



Visit BPI TECH FAIR.®
And stop giving your career
the run-around.

SEARCH ME!

For on-line technical
career opportunities and
to transmit your resume:
DIAL 612-941-3957



On your PC or terminal
and modem, enter the
password "BPI."
Search AdLine often, as
companies are continually
being added to the system.

Nation's #1 rated career event.

TECH FAIR®

BPI • 100 North Seventh Street • Minneapolis, MN 55403 • (612) 890-5561

1988 Schedule: Boston/Braintree — Jan. 11-12/Jan. 13, Orlando — Jan. 18-19, Washington, D.C. — Feb. 1-2, Long Island — Feb. 8-9, Denver — Feb. 22-23, Minneapolis — Feb. 29-March 1, Washington, D.C. — EEO — March 7-8, Phoenix — March 14-15, Boston — March 21-22, Dallas — March 28-29, Los Angeles — April 11-12, Rockville, MD — April 13-14, Meadowlands, NJ — April 18-19, Chicago — April 25-26, Houston — May 2-3, Santa Clara — May 9-10, San Diego — May 16-17, Detroit — May 23-24, North Haven, CT — June 6-7, Washington, D.C. — AFCEA/EEO — June 14-15, Boston — June 20-21, Huntsville, AL — June 27-28, St. Louis — July 18-19, Washington, D.C. — July 25-26, Phoenix — August 1-2, Los Angeles — August 8-9, Columbia, MD — August 15-16, Boston/Braintree — August 22-23/ August 24, Denver — August 29-30, Washington, D.C. — Sept. 12-13, Long Island — Sept. 19-20, Santa Clara — Sept. 26-27, Minneapolis — October 3-4, Chicago — EEO — October 10-11, Los Angeles — October 17-18, Dallas — October 24-25, Boston — November 14-15, Washington, D.C. — November 21-22, Orlando — December 5-6.

EDN Databank

Professional Profile

Announcing a new placement service for professional engineers!

To help you advance your career, Placement Services, Ltd. has formed the EDN Databank. What is the Databank? It is a computerized system of matching qualified candidates with positions that meet the applicant's professional needs and desires. What are the advantages of this new service?

- It's absolutely free. There are no fees or charges.

- The computer never forgets. When your type of job comes up, it remembers you're qualified.
- Service is nationwide. You'll be considered for openings across the U.S. by PSL and its affiliated offices.
- Your identity is protected. Your resume is carefully screened to be sure it will not be sent to your company or parent organization.

- Your background and career objectives will periodically be reviewed with you by a PSL professional placement person.

We hope you're happy in your current position. At the same time, chances are there is an ideal job you'd prefer if you knew about it.

That's why it makes sense for you to register with the EDN Databank. To do so, just mail the completed form below, along with a copy of your resume, to: Placement Services, Ltd., Inc.

IDENTITY

Name _____ Parent Company _____
Home Address: _____ Your division or subsidiary: _____
City _____ State: _____ Zip: _____ Location (City, State) _____
Home Phone (include area code): _____ Business Phone if O.K. to use: _____

PRESENT OR MOST RECENT EMPLOYER

EDUCATION

Degrees (List)

Major Field	GPA	Year Degree Earned	College or University

POSITION DESIRED

EXPERIENCE

Present or Most Recent Position _____ From: _____ To: _____ Title: _____

Duties and Accomplishments: _____

Industry of Current Employer: _____

Reason for Change: _____

PREVIOUS POSITION:

Job Title: _____

Employer: _____ From: _____ To: _____ City: _____ State: _____

Division: _____ Type of Industry: _____ Salary: _____

Duties and Accomplishments: _____

COMPENSATION/PERSONAL INFORMATION

Years Experience	Base Salary	Commission	Bonus	Total Compensation	Asking Compensation	Min. Compensation
Date Available	I Will Travel <input type="checkbox"/> Light <input type="checkbox"/> Moderate <input type="checkbox"/> Heavy			<input type="checkbox"/> I own my home. How long? _____ <input type="checkbox"/> I rent my home/apl. <input type="checkbox"/>		
<input type="checkbox"/> Employed <input type="checkbox"/> Self-Employed <input type="checkbox"/> Unemployed		<input type="checkbox"/> Married <input type="checkbox"/> Single		Height _____ Weight _____		
Level of Security Clearance		<input type="checkbox"/> U.S. Citizen <input type="checkbox"/> Non-U.S. Citizen	My identity may be released to: <input type="checkbox"/> Any employer <input type="checkbox"/> All but present employer			
<input type="checkbox"/> WILL RELOCATE <input type="checkbox"/> WILL NOT RELOCATE <input type="checkbox"/> OTHER _____						

EDN Databank

A DIVISION OF PLACEMENT SERVICES LTD., INC.

265 S. Main Street, Akron, OH 44308 216/762-0279

EDN's CHARTER

EDN is written for professionals in the electronics industry who design, or manage the design of, products ranging from circuits to systems.

EDN provides accurate, detailed, and useful information about new technologies, products, and design techniques.

EDN covers new and developing technologies to inform its readers of practical design matters that will be of concern to them at once or in the near future.

EDN covers new products

- that are immediately or imminently available for purchase
- that have technical data specified in enough detail to permit practical application
- for which accurate price information is available.

EDN provides specific "how to" design information that our readers can use immediately. From time to time, **EDN's** technical editors undertake special "hands-on" projects that demonstrate our commitment to readers' needs for useful information.

EDN is written by engineers for engineers.

EDN

275 Washington St
Newton, MA 02158
(617) 964-3030

Peter D Coley
VP/Publisher
Newton, MA 02158
(617) 964-3030; Telex 940573
Ora Dunbar, Assistant/Sales Coordinator

Deborah Virtue
Business Director
Newton, MA 02158
(617) 964-3030

Mark J Holdreith
Advertising Sales Director
Newton, MA 02158
(617) 964-3030
Heather McElkenny, Assistant

NEW ENGLAND
John Bartlett, Regional Manager
Chris Platt, Regional Manager
199 Wells Ave
Newton, MA 02159
(617) 964-3730

STAMFORD 06904
George Isbell, Regional Manager
8 Stamford Forum, Box 10277
(203) 328-2580

NEW YORK, NY 10011
Daniel J Rowland, Regional Manager
249 West 17th St
New York, NY 10011
(212) 463-6419

PHILADELPHIA AREA
Steve Farkas, Regional Manager
487 Devon Park Dr, Suite 206
Wayne, PA 19087
(215) 293-1212

CHICAGO AREA
Clayton Ryder, Regional Manager
Randolph D King, Regional Manager
Cahners Plaza
1350 E Touhy Ave, Box 5080
Des Plaines, IL 60017
(312) 635-8800

DENVER 80206
John Huff, Regional Manager
44 Cook St
(303) 388-4511

DALLAS 75243
Don Ward, Regional Manager
9330 LBJ Freeway, Suite 1060
(214) 644-3683

SAN JOSE 95128
Walt Patstone, Regional Manager
Bill Klanke, Regional Manager
Philip J Branon, Regional Manager
James W Graham, Regional Manager
3031 Tisch Way, Suite 100
(408) 243-8838

LOS ANGELES 90064
Charles J Stillman, Jr
Regional Manager
12233 W Olympic Blvd
(213) 826-5818

ORANGE COUNTY/SAN DIEGO 92715
Jim McErlean, Regional Manager
18818 Teller Ave, Suite 170
Irvine, CA
(714) 851-9422

PORTLAND, OREGON 97221
Pat Dakin, Regional Manager
Walt Patstone, Regional Manager
1750 SW Skyline Blvd, Box 6
(503) 297-3382

UNITED KINGDOM/BENELUX
Jan Dawson, Regional Manager
27 Paul St
London EC2A 4JU UK
44 01-628 7030
Telex: 914911; FAX: 01-628 5984

SCANDINAVIA
Stuart Smith
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

FRANCE/ITALY/SPAIN
Alasdair Melville
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

WEST GERMANY/SWITZERLAND/AUSTRIA
Wolfgang Richter
Sudring 53
7240 Horb/Neckar
West Germany
49-7451-7829; Telex: 765450

EASTERN BLOC
Uwe Kretzschmar
27 Paul St
London EC2A 4JU UK
01-628 7030
Telex: 914911; FAX: 01-628 5984

FAR EAST
Ed Schrader, General Manager
18818 Teller Ave, Suite 170
Irvine, CA 92715
(714) 851-9422; Telex: 183653

HONG KONG
John Byrne & Associates Ltd.
1613 Hutchison House
10 HGarcourt Road
Central Hong Kong
Tel: 5-265474
Tlx: 61708 WEDIN HX
Fax: 5-8106781

JAPAN
Kaoru Hara
Dynaco International Inc
Suite 1003, Sun-Palace Shinjuku
8-12-1 Nishishinjuku, Shinjuku-ku
Tokyo 160, Japan
Tel: (03) 366-8301
Telex: J2322609 DYNACO

KOREA
Kim Kyong-Hae, BK International
Won Chang Bldg, 3rd Floor 26-3
Yoido-dong, Youngdungpo-ku
Seoul 150, Korea
Tel: 785-6665; FAX: 784-1915
Telex: K32487 BIZKOR

**SINGAPORE/MALAYSIA/INDONESIA/THAILAND/
THE PHILIPPINES/AUSTRALIA/NEW ZEALAND**
Asia Pacific Media House PTE Ltd
Peter Cheong
100 Beach Rd
#24-03 Shaw Tower
Singapore 0718
Tel: 2915354; Telex: RS 50026 MESPLY

TAIWAN
Acteam International Marketing Corp
6F, No 43, Lane 13
Kwang Fu South Rd
Mailing Box 18-91
Taipei, Taiwan ROC
760-6209 or 760-6210
Telex: 29809; FAX: (02) 7604784

PRODUCT MART
Joanne Dorian, Manager
249 West 17th St
New York, NY 10011
(212) 463-6415

CAREER OPPORTUNITIES/CAREER NEWS
Roberta Renard, National Sales Manager
(201) 228-8602
Janet O Penn, Eastern Sales Manager
(201) 228-8610
103 Eisenhower Parkway
Roseland, NJ 07068

Ellen Sherwood, Western Sales Manager
12233 West Olympic Blvd
Los Angeles, CA 90064
(213) 826-5818

Maria Cubas, Production Assistant
(201) 228-8608

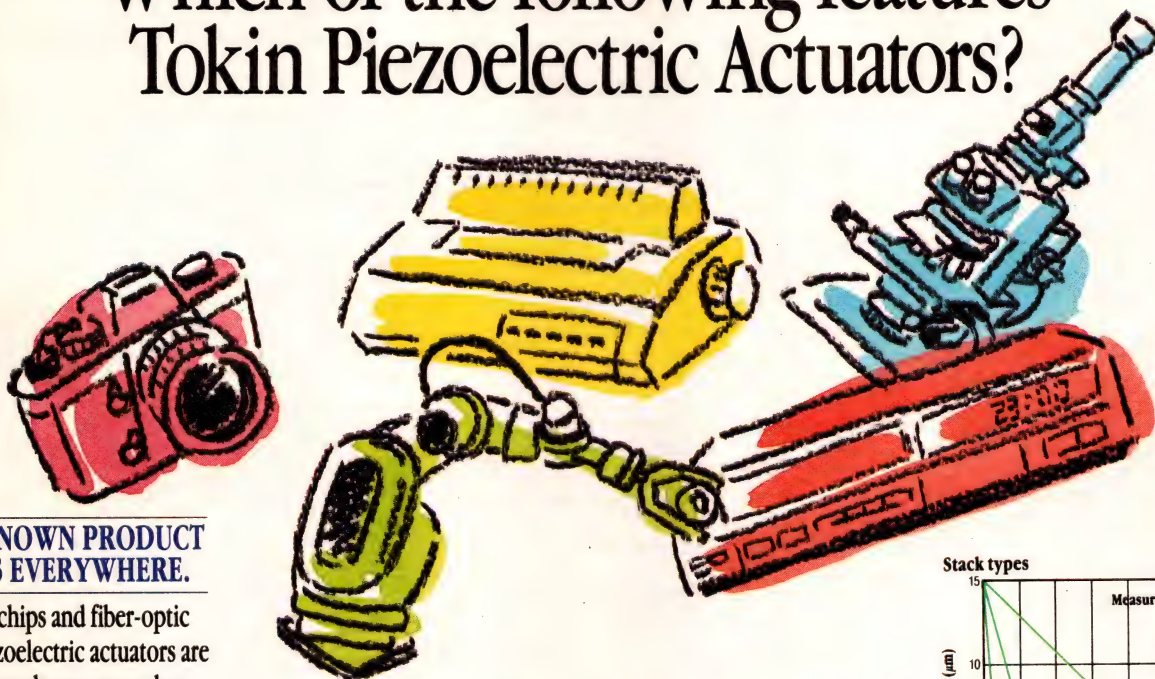
Susan M Campanella, Advertising/Contracts Coordinator
Nan Coulter, Advertising/Contracts Coordinator
(617) 964-3030

William Platt, Sr, Vice President, Reed Publishing USA
Cahners Magazine Division
Terry McDermott, President, Cahners Publishing Co
Frank Sibley, Group Vice President, Electronics/Computers
Tom Dellamaria, VP/Production & Manufacturing

Circulation
Denver, CO: (303) 388-4511
Sherri Gronli, Group Manager
Eric Schmierer, Manager

Reprints of EDN articles are available on a custom printing basis at reasonable prices in quantities of 500 or more. For an exact quote, contact Joanne R Westphal, Cahners Reprint Service, Cahners Plaza, 1350 E Touhy Ave, Box 5080, Des Plaines, IL 60018. Phone (312) 635-8800.

Which of the following features Tokin Piezoelectric Actuators?



They all do.

AN UNKNOWN PRODUCT THAT'S EVERYWHERE.

Like microchips and fiber-optic cables, piezoelectric actuators are products people use every day without even knowing it. They make camera shutter releases more accurate, and electronic microscopes more precise. They enable greater accuracy in robot positioning, VCR head tracking and printing head driving. In applications from fine-displacement elements for sub-micron positioning to fast-response, compact solid element motors, the piezoelectric actuator is an intrinsic part of daily life.

HOW TOKIN MAKES IT BETTER.

What's special about Tokin piezoelectric actuators is our unique manufacturing method: *solid-sintering* without adhesive material, using the thick-film multilayer technology. Combined with the HIP (hot isostatic press) process, it delivers the utmost in mechanical strength,

with negligible variation from repeated compression and expansion.

CAN YOU AFFORD TO BE WITHOUT TOKIN PIEZOELECTRIC ACTUATORS?

Tokin breakthroughs in piezoelectric actuators enhance the

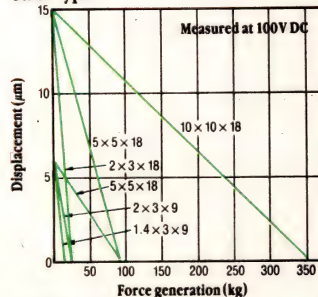
operation of many kinds of products. And the list of potential applications is rapidly expanding.

Couldn't a piezoelectric actuator enhance or improve your product? Call us today and find out more about the product and the company that's making a big difference in a multitude of products.

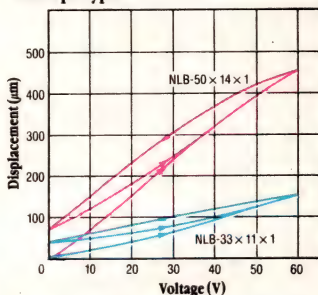


Now that you know what they do,
how many new applications can you think of
for Tokin Piezoelectric Actuators?

Stack types



Bimorph types



Performance

	Dielectric displacement ($\mu\text{m}/100\text{V}$) $\pm 10\%$	Force generation ($\text{kg}/100\text{V}$) $\pm 20\%$
Stack types		
NLA-1.4x3x9	6.5	14.0
NLA-2x3x9	6.5	21.0
NLA-2x3x18	15.0	21.0
NLA-5x5x9	6.5	87.0
NLA-5x5x18	15.0	87.0
NLA-10x10x18	15.0	350.0
Bimorph types	($\mu\text{m}/60\text{V}$) $\pm 20\%$	($\text{g}/60\text{V}$) $\pm 20\%$
NLB-33x11x1	150	30
NLB-40x12x1	300	30
NLB-50x14x1	450	48

Tokin

Tokin Corporation

Head Office: Hazama Bldg., 5-8, Ni-chome, Kita-Aoyama, Minato-ku, Tokyo 107, Japan Tel: Tokyo (03) 402-6166 Fax: Tokyo (03) 497-9756
Telex: 02422695 TOKIN J

Tokin America Inc.

155 Nicholson Lane, San Jose, California 95134, U.S.A. Tel: 408-432-8020 Fax: 408-434-0375

Chicago Branch: Presidents Plaza 1, Suite 200N, 8600 W. Bryn Mawr, Chicago, IL 60631 Tel: 312-380-0030 Fax: 312-693-8334

München Liaison Office

Elisabethstraße 21, 8000 München 40, Bundesrepublik Deutschland Tel: (089) 271 75 22 Fax: (089) 271 75 67 Telex: 5 24 537 tokin d

You can reach our agents by phone: London 01-837 2701; Paris 1-45 34 75 35; Milan (0331) 678.058; Munich (089) 5164-0; Seoul (02) 777-5767; Taipei (02) 7311425; Hong Kong 3-315769; Singapore 747-8668

ADVERTISERS INDEX

Abbott Transistor Laboratories Inc	135	Eagle Picher	292	Matra Harris Semiconducteurs	259
ACCEL Technologies Inc	299	Eaton Corp	305	Matsuo Electronics	233
Advanced Circuit Technology	186	Eclipse Technologies Inc	296	McCoy Electronics Co	286
Advanced Micro Devices	C2, 12-13	EG&G Almond Instruments	57	Measurement Systems Inc	297
Advanced Microcomputer Systems Inc	297	Electronic Designs Inc	277	Melcher	308
Advin Systems	3	Electronic Devices	300	Memocom	299
Airpax Corp/Cambridge Div	317	Electroswitch Corp	268	Mental Automation Inc	301
Allen-Bradley Co	185	Emcor Products/Crenlo Inc	269	Mepco/Centralab	169
Amatom Electronic Hardware	244	Endicott Research Group	54	Micro-Rel	322
American Automation	353	Engineering Tutorial Software	300	Micron Technology Inc	95
American Technical Ceramics	297	Epson America Inc	351	Microswitch	130-131
Amoco Laser Co	284	Ericsson Components	354	Microwave Systems Corp	275
AMP	174	E-T-A Circuit Breakers	301	Milpower Sources	188
Amperex Electronic Corp*	304	Excalibur	233	Mini-Circuits Laboratories	3, 4, 26, 27, 221
Analog and Digital Peripherals Inc	299	Finlux*	151	Modutec Inc	255
Analog Devices Inc	127, 196	First Systems	80	Molex Inc	356
Andyne Computing	300	Force Computers Inc	30-31	Motorola Microcomputer Div	118
Antona Corp	295	Fosters Engineering & Manufacturing Inc	243	M S Kennedy Corp	211
Apollo Computer	58-59	Fujitsu Components of America Inc*	147	National Instruments	114
Applied Microsystems Corp	72	Fujitsu Limited**	186D	National Semiconductor Corp	18-19
Archimedes Software Inc*	77	Futaba Corp of America	158	NCR Corp	271
Arium Corp**	290, 291	GCOM Inc	264	NDK	306
Arium Corp*	106	General Electric	315	NEC Corp	66-67
Arnold Magnetics Corp	250	General Silicones	302	Nicolet Test Instruments Div	136
Atmel Inc	111	Gillytron Inc	87	Nohau Corp	295
Avantek	318	Good Fold**	314	North Hills Electronics	312
Ballard Technology	298	Grammar Engine Inc	298	Octagon Systems	299
B&C Microsystems	298, 301	Hardigg Industries Inc*	159, 291	OKI Semiconductor	28-29
Belden Wire & Cable	360	Harris Semiconductor Products	81-82, 83-86, 177, 238	Omatron Inc	298
Bergquist Co	310	Heurikon Corp	240	Ontario Ministry of Industry Trade & Technology	329
BKC International Electronics	186	Hewlett-Packard Co*	6, 16-17, 102, 103-104, 105, 121-122, 123, 137, 157	Optimal Technology	298
BKL Industries	302	Hitachi America Ltd*	289	OrCAD Systems Corp	160
Bomco Inc	52	Hypertronics Corp	217	Orion Instruments	229
Bonar Powertec	154A-F, 242	Hy-Tek Systems Inc	230	P-Cad	47
BP Microsystems	300	IBM Corp	198-199	PEP	319
Burr-Brown Corp	189	IEE	204	Philips Components**	186
Burr-Brown Corp*	260-261	ILC Data Device Corp	225	Philips T&M	77, 106
BV Engineering	298	Industrial Devices Inc	251	Phillips 66 Co	235-236, 239
Bytek Corp	298	Infrared Industries Inc	116	Phillips Components Inc	186B-C, 327
Caddock Electronics Inc	132	Inmos Ltd*	10-11, 173	Planar Systems	155
California Eastern Labs Inc	126	Inno-Sol Corp	300	Polytronix Inc	120
Capital Equipment Corp	299	Instant Board Circuits Corp	272	Power Conversion	252
Carlingswitch Inc	287	Integrated Circuits Inc	297	Power General	278
Carroll Touch Inc	149	Integrated Device Technology Inc	97	Precision Echo	297
Catalyst Research	248	Intel Corp	52, 54, 110, 115, 119, 128	Precision Filters Inc	280
Cedrus	298	Intergraph Corp	25	Precision Monolithics Inc	33
Cherry Electrical Products Inc	153, 300	Intusoft	301	Prem Magnetics Inc	2
Chips and Technologies	55-57	IRC Inc	172	Pulizzi	295
Chomerics Inc	124-125	IRT Corp	288	Pulse Instruments	276
Ciba-Geigy**	202-203	Itac Systems Inc	296	Qua Tech Inc	296, 301
Circuit Technology Inc	14-15	ITT Cannon	23	Qualidyne Systems Inc	252
C&K Components Inc	309	Janco Corp	117	Radstone Technology	293
Comair Rotron Inc	119	JETA Power Systems	241, 243, 245	Raytheon	75
Comlinear Corp	50-51	John Fluke		REL Systems	295
Consumer Microcircuits Ltd**	151	Manufacturing Co Inc*	20, 48-49	Rogers Corp	68-69, 265, 296, 297, 301
Conversion Devices Inc	299	Jonathan Mfg Co*	290	Sabtech Industries	295
Cooper Tools*	187	Kadak Products	296	Samsung Semiconductor*	35-46
Corning Materials	313	Kemet Electronics	133	Shelly Associates	297
CTS Corp	170	Kepco Inc	282	Shin Hsin Precision	299
Cybernetic Micro Systems	296, 300, 302	Leader Electronics Inc	300	Siemens	129
Dage Precision Industries Inc	254	Leader Instruments Corp	227	Siemens AG, Karlsruhe**	10-11, 48-49, 186, 200-201
Dale Electronics Inc	1	Lectromagnetics Inc	320	Silicon General	171
Data Display Products	294	Linear Technology Corp	218	Silicon Systems Inc	112, 113
DATA Inc	311	Litton	294	Simpson Electric Co	273
Data I/O Corp	8, 279	Logical Systems Corp	302	Single Board Solutions	301
Data Modul GmbH	274	Lucas Ledex	232	Sipex Corp	175
Datron	190	LXD Inc	279	Skydyne	34
Delevan Div, API	303	3M Co	321	Sonotek	297
Deltrol Controls	296	Mallory Capacitor Corp	281	Sony Component Products	109
Deltron Inc	233	MathSoft Inc	352	Spang Power Control	296
Densitron Corp	115			Spectron Glass and Electronics	249
Dialight Components	195				
DSP Development Corp	278				

EPSON IC MEMORY CARDS

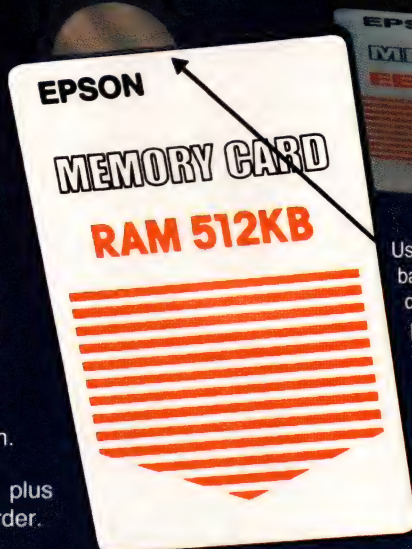
2.4 mm thin + Epson quality

BUILT TO LAST

Epson IC Memory Cards are engineered like no others . . . they are the fastest, thinnest, toughest, most reliable cards made, and have the highest industry ratings for suppression of EMI plus protection from ESD and contaminants.

Durable stainless steel outer panels cover a high-impact resistant core. Unique package provides 25,000 volts ESD protection and EMI noise suppression. The card connector's grounding system adds to the cards ESD and EMI noise protection for overall system isolation.

Epson offers IC Memory Cards from stock, plus Mask ROM and other customs made to your order. All Epson IC-Memory Cards of the same pin type are interchangeable . . . ideal wherever small, rugged and portable memories are required.



User replaceable battery for SRAM cards . . . plus write protect switch.

2.4 mm thin cards fit standard connectors for 8-bit (34/40-pin) or 16-bit (50-pin) bus applications.

SRAM Card has 150 ns access time . . . the best available by far!

EEPROM Card Series
8K to 32K Bytes

EPROM Card Series
32K to 1024K Bytes

Mask ROM Card Series
32K to 2048K Bytes

SRAM Series
8K to 512K Bytes



Contacts are covered by a unique protective shutter that slides open as card is inserted into the connector. Long-life contacts permit cards to be inserted and removed a minimum of 10,000 times. Inquire about Z.I.F. type connector for 100,000 cycle applications.

Call or write for complete information

EPSON
Epson America, Inc.

Component Sales Department
3415 Kashiwa Street, Torrance, CA 90505

Telephone (213) 534-4500 • Telex 664277 • FAX (213) 539-6423

CIRCLE NO 244

"MATHCAD IS THE BEST THING TO HAPPEN TO THE ENGINEER SINCE THE POCKET PROTECTOR."

— PC Magazine

For problems involving engineering calculations or scientific analysis, the answer is MathCAD®.

MathCAD is the only PC-based software package specifically designed to give technical professionals the freedom to follow their own scientific intuition. You decide how to solve the problem – MathCAD does the "grunt work."

- Ends tedious programming and debugging.
- Displays instant answers as you change variables.
- Generates quick plots to help you view results.

MathCAD includes such built-in features as:

- Matrix operations
- Simultaneous equation solver
- Real and complex numbers
- Dynamic error flagging
- Automatic unit conversions
- Greek character set
- Fast Fourier Transform and much more

To find out what MathCAD can do for you, call us today for a **free demo disk: 1-800-MathCAD** (in MA, 617-577-1017). Or write to MathSoft, Inc., One Kendall Square, Cambridge, Massachusetts 02139.

Requires IBM® PC or compatible, 512KB RAM, graphics card.

Math Soft

$\Sigma + \sqrt{-} = \times \int \div \delta$

Software Tools for Calculating Minds

CIRCLE NO 246

We didn't get to be the best by accident...

We did it by design.

Surface Mounted Crystals from Statek.

Manufactured in the United States (with SPC), our miniature quartz crystals range from 10 kHz to 32 MHz. These small crystals are in hermetically-sealed rugged ceramic packaging. Testing to MIL specs, other features include *extremely* low power consumption, low aging, resistance to high shock and high temperature.

It's no accident Statek crystals are specified by thousands of engineers throughout the world!

A TECHNICORP COMPANY



STATEK CORPORATION
512 N. Main Street
Orange, CA 92668
(714) 639-7810

AD INDEX

Spectrum Software	53
Sprague Electric Co	79
Statek	352
Stimpson Co Inc	154
Street Electronics	241
Sun Circuits Inc	266
Tachai Industrial**	328
Tadpole Tech	247
Taiwan Liton Electronic Co Ltd	267
Taiyo Yuden (USA) Inc	307
Targa Electronics Systems Inc	298
TEAC Corp**	173
Technitrol Inc	285
Tektronix Inc	62-65
Teledyne Solid State Products	263
Titan/SESCO	178
TL Industries Inc	253
Tokin Corp	349
Toko America Inc	70
Topaz Semiconductor	262
Uniform Tubes Inc	245
United Technologies Microelectronics Center	167
Unitrode Corp	176
Universal Data Systems	359
US Instruments Rentals	299
Varta Batteries Inc	234
Viking Connectors Co	249, 251
Visionics Corp	90
Waferscale Integration Inc	88-89
Warden Tronics Inc	296
Wasatch	20
Whitesmiths Ltd	268
Winchester Electronics	297
WinSystems Inc	300
Wintek Corp	298, 299
Xeltek	301
Xicor Inc	60
Zax Corp	101
Zericon	302
Zilog Inc	223

Recruitment Advertising 330-347

Ball Aerospace
Boeing
Emerson Electric
FMC Corp
GE Government Electronics
GE Systems Engineering
General Dynamics
ISC Defense
Jack Porter Assoc
Jet Propulsion Labs
Martin Marietta
Micron Technology
Personnel Recruiting & Placement Associates
Smith's Industries
Sverdrup Technology
Textron Defense Systems

*Advertiser in US edition

**Advertiser in International edition

This index is provided as an additional service. The publisher does not assume any liability for errors or omissions.

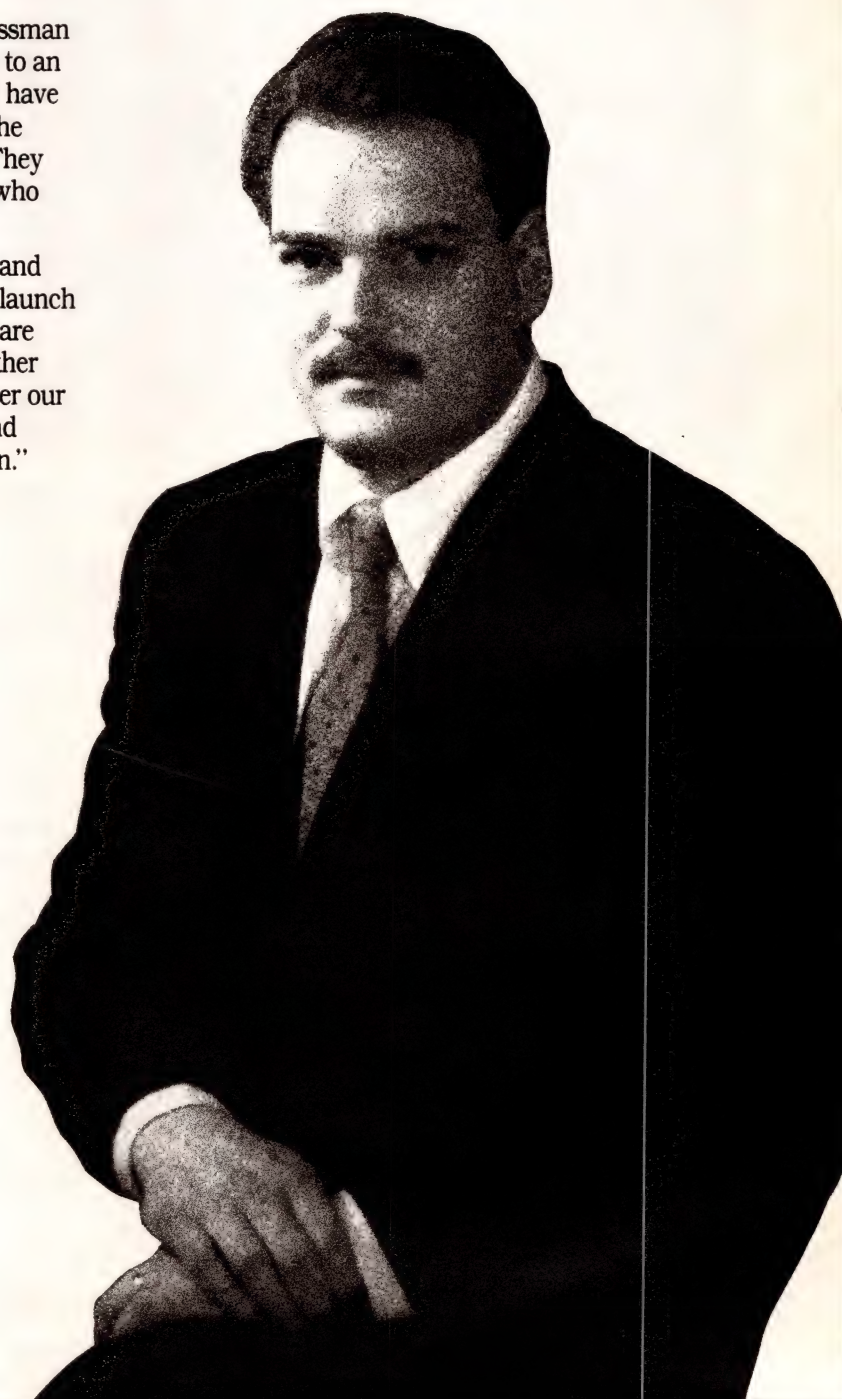
"I COUNT ON **EDN MAGAZINE** AND **EDN NEWS** TO CREATE WORLDWIDE BRAND AWARENESS FOR OUR POWER SUPPLIES."

John R. Belden
Marketing Manager
Glassman High Voltage, Inc.

Glassman High Voltage designs and manufactures high-voltage DC power supplies with a difference. The most striking difference is that they're insulated with air, and contain no oil or potting compound.

Marketing Manager John R. Belden has watched Glassman grow from a small shop with a lot of innovative ideas to an industry leader. And EDN magazine and EDN NEWS have helped along the way. "The two publications get us the brand recognition and prestige we need," he says. "They go right to the engineers and engineering managers who make the buying decisions."

John Belden believes in the power of EDN magazine and EDN NEWS. So much so that he's relying on them to launch a series of new product lines. "EDN and EDN NEWS are sure to get them off the ground," says Belden. "No other pair of publications can provide the influence to deliver our message to as many markets, both geographically and demographically, in a cost-effective and timely fashion."



EDN magazine and EDN NEWS work for Glassman High Voltage. They can work for you.

EDN

Where Advertising Works

*EriPower™

—The Reliable Source—



Ericsson miniature DC/DC Converters for your great, great, great, great grandchildren!

Incredible as it may seem, EriPower dc/dc converters have been designed with an MTBF of over 200 years, which means that 37% will still be working six generations from now!

Both EriPower PKA (25 to 40 Watt) and EriPower PKC (15 Watt) converters are the latest technology: hybrid construction with surface mounting components, 300kHz switching frequency and efficient thermal management. As a result, both are very small and up to 85% efficient. And both offer single, dual or triple 5, 12 and 15V output combinations from nominal 24V or 48V inputs.

There are three mounting options too. The PKA can be chassis mounted "Off-Card" or pcb mounted "On-Card". The advanced PKC can be mounted "On-Card" or "In Card" through a slot in the board. This unique "In-Card" mounting results in a maximum height of only 0.33" (8.5mm)!

To summarize, if you need reliable, compact and flexible power, from a totally reliable source, take a look at the EriPower range of dc/dc converters. They're easy to use, and need no external components. Paralleling for higher power or redundancy is achieved by a simple connection and they meet every major international specification for RFI without external filtering.

You can't make a better choice for future generations!

ERICSSON 

RIFA Inc

P.O. Box 853904 Richardson Texas 75085-3904
Tel: (214) 480-18300
Telex: 735389 ERICS RCHN
Fax: (214) 680-14059

*EriPower™ is a trade mark for standard power products from Ericsson Components AB's power department, formerly known as RIFA Power Products.

LOOKING AHEAD

EDITED BY CYNTHIA B RETTIG

Manufacturers praise JIT logistics

In response to a survey recently conducted by Touche Ross (Chicago, IL), 90% of a group of manufacturers and distributors said just-in-time (JIT) logistics were strategically important to developing or maintaining a competitive advantage. Once companies have put JIT plans into effect, they can deliver products in a short period of time while investing minimally in inventory needs. Companies have found that producing just what is needed and delivering exactly the right quantity at precisely the right time not only lowers inventory requirements but also improves a manufacturer's or distributor's relationships with both vendors and customers. About 25% of the nearly 200 respon-

dents already had operational JIT programs; another 50% or more are in the planning or start-up stages.

Operational JIT programs reduce the number of primary vendors any individual company deals with by an average of 42%, Touche Ross found. And when companies purchase more goods from fewer vendors, they have a better opportunity to influence those vendors' quality-control programs and to reduce purchase lead times. As companies thus reduce the number of vendors and improve their relations with them, the companies become much more satisfied with the quality of the goods and services received. Sixty percent of those with operational JIT programs stated that they were very satisfied with vendor quality; only 18% of those in the planning

stages for JIT said they were as pleased.

Manufacturers with JIT programs also benefited from improved relationships with their customers. Those companies found they could reduce costs while providing better customer service—including more frequent, as well as more timely, deliveries.

Touche Ross found that implementing just-in-time programs is not without its obstacles, however. Some manufacturers, for example, faced internal organizational resistance, lack of systems support, and limitations in manufacturing facilities. Others encountered difficulties defining service levels, inadequate amounts of purchased goods, and generally poor implementation of JIT planning.

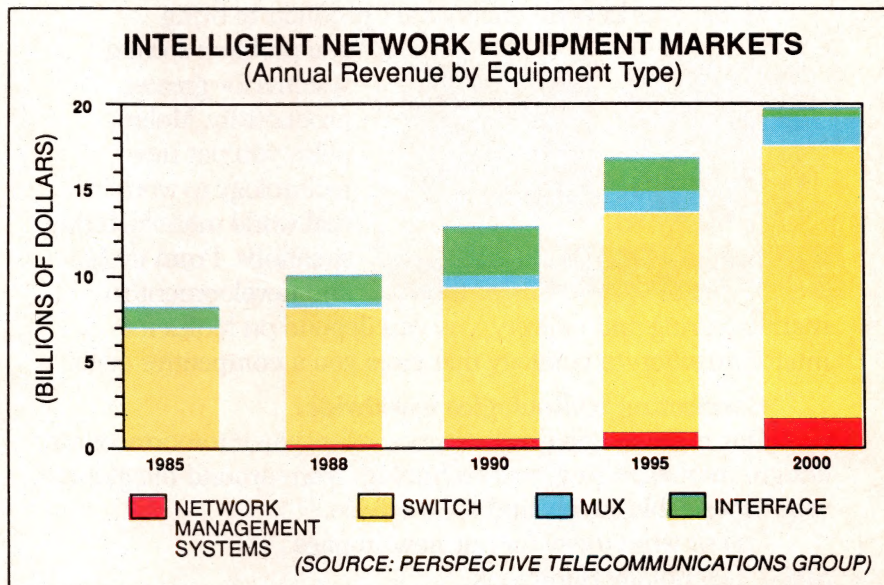
\$20B market predicted for smart network equipment

Annual sales of equipment for intelligent telecommunications networks should reach \$20 billion by the year 2000, according to the Perspective Telecommunications Group, a marketing research and management consulting firm specializing in telecommunications (Franklin Lakes, NJ). Prospective buyers will be looking for different qualities in different types of products. The extent to which intelligent switching gear improves system performance, for instance, will be critical to its success. On the other hand, customers will judge network management systems by ease of use. The market-research firm also points out that not all kinds of intelligent network equipment will flourish. Some products, like protocol converters, will actually decline in sales between the

years 1990 and 2000.

Perspective also identifies specific areas where opportunities in public as well as private network development exist, including switch manu-

facturing, data-communication equipment, LANs, computer manufacturing, and other vendors of equipment, information, and services.



Making the Connection Between...

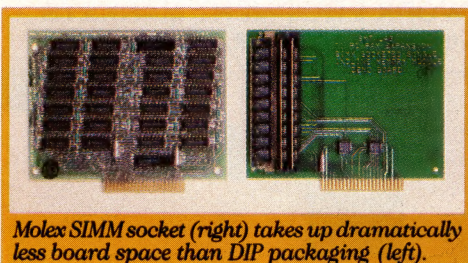
PACKAGING & PRODUCTIVITY

From through-hole technology to surface-mount technology, Molex makes the connection.

Molex is working to help today's manufacturers develop SMT products that utilize less space and assemble with greater efficiency. Components such as our SIMM sockets are currently helping major manufacturers utilize innovative SIP technology to achieve denser circuit board packaging and increased RAM capacity. And, systems such as our automated robotic PCB assembly equipment are speeding production time and reducing labor costs.

We take a systems approach to help make your bottom line more productive.

Molex goes beyond quality SMT products to bring



Molex SIMM socket (right) takes up dramatically less board space than DIP packaging (left).

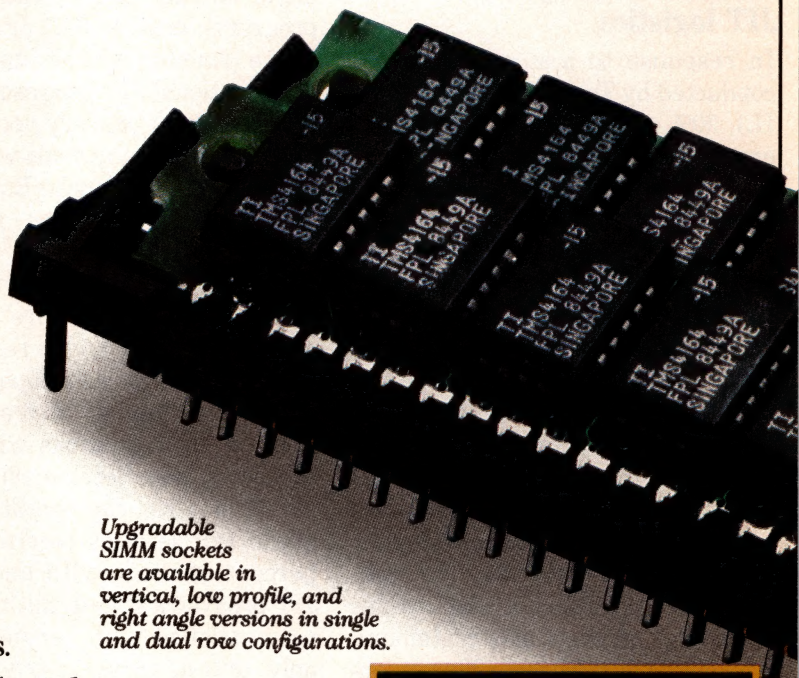
you problem-solving systems for greater productivity. Molex helps you put new technology to work in real world manufacturing situations. From design and development to

manufacturing and delivery, you can depend on Molex for interconnection technology that gives you a competitive edge.

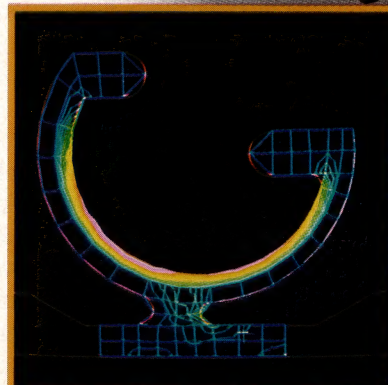
Connecting technologies worldwide.

Our multi-national organization offers you interconnection design, manufacturing, and technology from around the globe, with dependable supply and local service.

Call or write today for our new 16-page SIMM Technology Handbook.



Upgradable SIMM sockets are available in vertical, low profile, and right angle versions in single and dual row configurations.



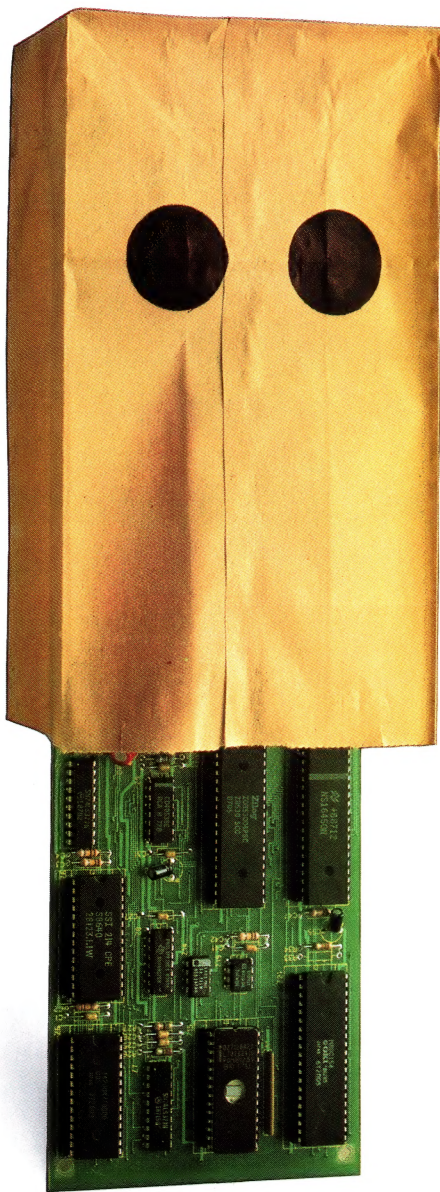
As part of our intensive quality assurance efforts, CAD technology is used in product development to identify possible stress points.

Service To The
Customer...Worldwide



SIMM™ is a registered trademark of the Wang Corporation.

Corporate Headquarters: 2222 Wellington Ct., Lisle, IL 60532 USA, (312) 969-4550 • **European Headquarters:** Munich, West Germany, 49-89-4960937
Northern Asia Headquarters: Tokyo, Japan, 03-487-8333 • **Southeast Asia Headquarters:** Jurong Town, Singapore, 65-265-4755



We build anonymous modems for our famous friends

Some of our best OEM customers don't want to be identified; we understand. They're among the world's leading suppliers of computers, intelligent terminals, graphics and engineering workstations and other equipment that requires built-in data communications capability.

These well-known companies have selected UDS as their modem supplier because we provide front-

running technology, superb manufacturing capability, unmatched customer support...and discretion. In a word, UDS modems give their products the kind of reliability they like to claim as their own.

UDS has a broad selection of OEM "standard" designs on file; we also offer industry-leading capability for the development of custom boards. Combined, these two approaches have already

placed more than 3,000 modem designs into active field service.

If you're one of the big boys — or if you want to solve data-comm problems the way the big boys do — find out what UDS recommends as a cost-effective solution for you. Contact Universal Data Systems, 5000 Bradford Drive, Huntsville, AL 35805. Telephone 205/721-8000; Telex 752602 UDS HTV.



Universal Data Systems



MOTOROLA INC.

CIRCLE NO 250



4 REASONS TO SPECIFY BELDEN FOR YOUR GOVERNMENT AND MILITARY APPLICATIONS

Selection. We offer a broad line of electronic wire and cable designed to meet military specifications such as MIL C 17, MIL C 49055, MIL W 16878, MIL W 22759 and others. Many are QPL listed.

From fiber optic cable to multi-conductor and high

temperature cables, choose the cable best suited to your specific application. Or work with our Product Engineering Group to design specialty cable to your exact requirements.

Belden Innovation.

We're a leading innovator in shielding technology and patented testing methods. Our shielding is designed to meet the highest performance standards in the industry—including military TEMPEST requirements. To make your cable decision easier, we provide you with all the test data necessary to choose the proper and most cost-efficient shield for your application. We also offer a variety of insulations and jacketing materials designed to provide superior performance under hostile environmental conditions. Critical application requirements are not a problem when you work with Belden.



Quality and Reliability.

After working with governmental and military applications for over 30 years, we understand the interrelationship of quality components and critical requirements. We believe quality is the responsibility of leadership. That's why our Quality Assurance Department has full authority to maintain high quality standards for our

products. And we use patented testing methods to guarantee our product reliability. Choosing Belden means choosing high quality, reliable products.



The Belden Government Department. Since we understand how the government and prime contractors work, we provide you with full support services—from sales and engineering support to contract administration. We're ready to help with your design decisions where and when you need us.

To make your design project easier, call us for technical assistance. Because when you specify Belden, *There is no equal.*

Contact the Belden Wire and Cable Government Department today. P.O. Box 1980, Richmond, IN 47375.

Phone: 1-800-BELDEN-4
(In Indiana, call 317/983-5200)

There is no equal.™

CIRCLE NO 251

SEE OUR CATALOG IN EEM

Copyright © 1986, 1987 Cooper Industries, Inc.



BELDEN